SOLAR DOMESTIC WATER HEATING
VILLA PROVIDENCE
SHEDIAC, N.B.

March, 1985

CREDA Project #2009

Prepared by: Aldore LeBlanc

Canada/New Brunswick Conservation and Renewable Energy Demonstration Program

The Conservation and Renewable Energy Demonstration Program Program is administered in New Brunswick by the Energy Secretariat and managed jointly with Energy, Mines and Resources Canada. The Program is designed to help demonstrate promising conservation and renewable energy technologies, to develop public awareness and understanding of these technologies, and to create employment in new or existing industries.

Through over 100 demonstration projects in New Brunswick, a wide variety of conservation and renewable energy technologies have proven to be technically sound and economically attractive. These demonstration projects should now provide a catalyst for commercialization and lead to widespread adoption of many of these proven technologies.

This final report is based on a project which was financially supported by the Energy Demonstration Program. For further information on other demonstration projects funded in New Brunswick under this program, contact:

Conservation & Renewable
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P.O. Box 6000
Fredericton, N.B.
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(506) 453-3897

Programme Canada/Nouveau-Brunswick de démonstration des économies d'énergie et des énergies renouvelables

Le Programme de démonstration des économies d'énergie et des énergies renouvelables est administré au Nouveau-Brunswick par le Secrétariat à l'énergie, en collaboration avec Energie, Mines et Ressources Canada. Ce programme tente d'abord de vérifier la fiabilité des techniques de conservation d'énergie, d'accroître la sensibilité du public envers ces techniques et, enfin, de favoriser la création d'emplois au sein des industries nouvelles ou déjà existantes.

Un grand nombre de projets de démonstration se sont avérés à la fois techniquement réalisables et économiquement attrayants.

Le succès ainsi rencontré encourage la commercialisation des procédés les plus accessibles. Cela entraînerait certes l'adoption d'un grand nombre de ces techniques par les propriétaires de domiciles et par l'industrie privée.

Ce rapport final est basé sur un projet qui a reçu une aide financière du Programme de démonstration. Pour de plus amples renseignements, communiquez avec la:

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et des énergies renouvelables
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D E N I D E R E S P O N S A B I L I T E

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TABLE OF CONTENTS

Page

1. An Executive Summary 1
2. Introduction and Background.. 3
3. General Description of the Demonstration 5
4. Observations during Installation and Monitoring.. 8
5. Cost/Benefit Analysis..... 12
6. Conclusions 14
7. Recommandations..... 17
8. Supporting Material..... 19

AN EXECUTIVE SUMMARY

In April 1980, the Board of Directors of Villa Providence Shediac Inc. were informed by their Chairman, Jean-Claude Belliveau, that grants were available for energy saving systems for non-profit organizations.

An ad-hoc Committee was appointed and visited the Petro-Sun Solar Division in Montreal on May 31, 1980. The concept discussed would demonstrate the potential of solar energy when utilized to heat a large quantity of domestic hot water.

The project would be a first in the Atlantic Provinces and would act as a catalyst for the commercial application of solar energy.

It was felt that most of the emphasis, to date, in the field of solar heat had been applied to space heating. This had not proven to be efficient in Eastern Canada, as too many collectors were required to be practical and the five (5) most important months of winter were lost, while in the summer months, space heating would not be required.

On the other hand, solar heating of domestic hot water would be much more efficient. The system would be in operation during most of the year and would attain an efficiency of almost 90% during the summer months. This type of project would be especially applicable to our organization, a 200-bed nursing home with a high consumption of domestic hot water for cooking, maintenance, laundry and health care services.

The solar heating system would consist of 4,271 square feet of solar collectors mounted at a 30^{o} angle; a 6,000 gallon hot water storage tank was proposed with an interconnecting system of pipes and electronic controls, double pressure pump and hydropneumatic water tank.

Since the concept was original with some experimentation, we encountered many problems during the installation. Many of the original ideas did not prove to be totally practical and they were modified or revised.

The project is now completed and working quite efficiently. Monitoring will be carried out during the summer months and should provide some very interesting statistics.

1.0 SOMMAIRE RECOMMANDATION

En avril 1980, le président du Conseil d'administration de la Villa Providence Shédiac Inc., Jean-Claude Belliveau, apprenait aux membres que les organisations sans but lucratif pouvaient profiter de subventions pour l'installation de systèmes d'économie de l'énergie.

On a formé un comité ad hoc qui a visité la Petro-Sun Solar Division à Montréal le 31 mai 1980. Le concept discuté permettrait de démontrer le potentiel de l'énergie solaire comme source de chauffage d'une grande quantité d'eau domestique.

Le projet serait une première dans les provinces de l'Atlantique et servirait de catalyseur pour l'application commerciale de l'énergie solaire.

Jusque-là, presque toute l'attention dans le domaine de l'énergie solaire semblait avoir été accordée au chauffage des locaux. Mais cette technique ne s'est par montrée très efficace dans l'est du Canada, car il fallait trop de capteurs pour rendre le système pratique. Les 5 (cinq) mois les plus importants de l'hiver étaient perdus, tandis que pendant les mois d'été le chauffage des locaux était inutile.

D'autre part, le chauffage solaire de l'eau domestique serait beaucoup plus efficace. Le système fonctionnerait pendant la

plus grande partie de l'année et présenterait un rendement de 90 % pendant les mois d'été. Ce genre de projet conviendrait parfaitement à notre organisation, un foyer de soins de 200 lits présentant une forte consommation d'eau chaude domestique pour la cuisson, l'entretien, le lavage et les soins hygiéniques.

Le système de chauffage solaire consisterait en 4271 pi de capteurs solaires montés à un angle de 30 ; on nous proposait également un réservoir d'eau chaude de 6000 gallons muni d'un système d'interconnexion et de commandes électroniques, d'une pompe à double pression et d'un réservoir d'eau hydropneumatique. Comme le concept était nouveau et avait été peu expérimenté, nous avons connu bien des problèmes pendant l'installation. Bon nombre des idées originales se sont révélées partiellement inutilisables et on a dû les modifier ou les reviser.

Le projet est maintenant terminé et fonctionne assez efficacement. Le monitorage se poursuivra pendant les mois d'été et on prévoit obtenir des statistiques très intéressantes.

INTRODUCTION AND BACKGROUND

On September 25, 1980, a Committee of Villa Providence Shediac Inc. of Shediac, N.B., presented a brief to the Energy Secretariat of New Brunswick. The brief requested a solar water heating system for domestic hot water for a 200-bed nursing home.

On January 30, 1981, the Minister of Finance, Honorable Fernard Dube, Q.C. informed us that our proposal entitled "Systeme solaire", submitted under the program for the demonstration of conservation and renewable energy technology, received approval by the Management Committee on December 17, 1980.

Tenders were received on July 17, 1981 as follows:

Key Mechanical	$192,700.00
Parson's Construction	165,905.00
Moncton Plumbing	187,700.00
Blair's Plumbing	108,500.00

The contract was awarded to Blair's Plumbing on August 14, 1981 with minor changes negotiated with cost adjustments made to $105,000. It was also requested that charges for any extras, if required, be stated. A separate contract was awarded to AMAR Electric Ltd. for $9,000.00.

The proposed system would include solar collectors, pumps, ducting, piping and storage tank for a large institution.

The system will provide 54% of total energy requirements for hot water consumption of 9,000 gallons per day. As well, this technology should have broad applications in other institutional, commercial and industrial buildings.

In March, 1982, an economic analysis of the project cost was established as:

Capital Equipment	$119,580.00
Installation	63,000.00
Total	$182,580.00
Monitoring	63,920.00
Total Demonstration Cost	$246,500.00

The energy impact: 7580 gallons of oil at $1.06/gallon are displaced by solar energy, thereby providing a net annual savings of $8,034.00 and a pay-back of approximately 30.7 years based on gross costs. A pay-back of 22.7 years is expected if only capital costs are incurred.

Actual Project Cost: $313,870 (See Page 12)

Contributors:

Villa Providence	$108,710
Canada-New Brunswick CREDA	$205,160
	$313,870

GENERAL DESCRIPTION OF THE DEMONSTRATION

1. Collection System

The solar pre-heating collection system at Villa Providence Shediac Inc. consists mainly of two separate banks of high-efficiency liquid solar collectors mounted on the south side roof of the building and occupying a total surface area of 4,471 square feet and weighing 5.8 lb/sq. ft. These collectors are supported by steel frames installed on the roof and inclined at 30° with the horizontal.

The collectors are of the flat plate type using copper covered with a selective black chrome as absorber plates.

The solar fraction is expected to be in the area of 54%.

A solar differential controller has been installed in order to activate (stop or start) the solar circulating pumps when the proper differential exists between the water temperature inside the collectors and the water temperature inside the holding tanks. If the spread in temperature between these two points is large enough, the solar circulating pumps will start and if the differential is too small the pumps will stop and the water will drain down so it will not freeze in winter, for example, or if it cannot provide useful heat to the storage side of the heat exchangers.

Sensors have been installed on the collector line and holding tank so that the system works automatically (see section on Monitoring).

All collectors have been linked with copper piping (except for some baffle joints) and soldered with a

mixture of 95/5 zinc and lead, All the remainder soldering has been accomplished by using a 50/50 zinc and lead solder.

The exterior piping has been insulated with Armaflex (R=12, RSI 2.1)and the interior piping with Armaflex (R=8, RSI 1.4)

Manual control valves have been installed on each row of collectors in order to properly balance the water flow (to maximize the heat transfer from collector absorber to water) in each series of collectors.

Expansion joints have been installed between various series of collectors in order to eliminate thermal stress.

2. Type of System

Due to the large volume of liquid used in the collectors a drain down type of system has been installed with an insulated drain-down tank of 300 gallons open to atmospheric pressure. This tank is located just below the bank of collectors and receives the drain-down water by gravity as soon as the solar circulating pumps on the collector side stop pumping. One circulating pump per bank is used in the collection loops.

3. Heat Transfer

Solar side of heat exchanger - To keep the water used in the collectors separate from the domestic hot water, a heat exchanger has been installed in the solar room near the drain-down tank (see plans). It also offers an efficient means of heat transfer.

Transfer side of heat exchanger - A circulation pump pushes water from the three (3,000 gal) tanks in the transfer side of the heat exchanger to extract the heat from solar side of the exchanger and this causes the pre-heating of the water-main water. This pre-heated water is then boosted to house pressure by booster pumps and fed to the auxiliary

domestic water heater to be heated to the required temperature.

*NOTE: See plans for details and specifications.

OBSERVATIONS DURING INSTALLATION AND MONITORING

1. Monitoring

To provide a good monitoring system from our solar energy system, the following equipment and location were chosen:

- 5 kilowatt/hour meters
  Westinghouse # D4A2/CD1-22B

These meters are located to provide us with a reading of the amount of electricity used by the circulating pumps on the solar system and the boiler motors.

Two of the meters were installed on the boiler motors. This will enable us to calculate the electrical cost for the boilers.

Three of the meters were installed on the energy system's circulating lines. This also will enable us to calculate the electrical cost for running the pumps.

Five Neptune water meters, of which are: 4 type "5", 2 inch meters with type 34 pulser c/w flanges. One full flow Crest meter, 3 inches with type pulser, c/w flanges.

These water meters are installed to provide readings of water energy supplied and used.

Two of the type 5 meters were installed on the solar collectors circulating lines.

Two of the type 5 meters were installed on the outlet lines of our laundry and domestic hot water tanks.

One full flow crest meter was installed in the 6,000 gallon reservoir tank's circulating line.

- 4 Neptune oil meters
  VLF8, 3/8", c/w Pulser

Oil meters were installed on the feed and return oil lines of both boilers. They will enable us to read the oil consumption of each boiler to calculate the cost of operation.

- 10 Integrated bolt-on sensors

These sensors are installed at various locations to enable a reading of the water temperature at different spots in the system. The sensors control the on-off operation for calculation of the energy supplied by the solar energy system and the boilers.

Two sensors were installed on the outlet lines of each solar collector.

Two sensors were installed on the inlet line of the heat exchanger's second stage.

Two sensors were installed on the outlet lines of our two hot water tanks.

One sensor was installed on the inlet line of the solar collector.

One sensor was installed on the cold water supply line.

One sensor was installed on the 6,000 gallon storage tank hot water outlet.

One sensor was installed for ambient temperature on the roof.

- An APPLE computer system consisting of:
  - one APPLE II E computer
  - Two Floppy disc drives
  - One 12" colour monitor
  - One 15" pro-writer printer

- One ISAAC Controller System consisting of:
  - One Isaac controller # 91A
  - One I-100 input card
  - Two I-120 expansion cards
  - One Apple documentation package # 860 - 037

The two systems enumerated above will be programmed to accept data from field equipment. They will be combined to calculate the information necessary to illustrate the performance of our solar energy system and boilers.

2. Technical Performance

In order to operate the solar energy system, an investigation had to be performed to determine why the system didn't operate to specifications. During the investigation we noticed a few things that were wrong.

When the system was installed the wrong sensors were placed in operation. The solar controller did not work on automatic so the only way the circulating pumps worked was manually. We noticed while checking out the sensors that there were thermisters instead of analog output sensors. They were replaced.

This was not the only problem. The sensor on the roof level was in the wrong location. It was almost six (6) feet from the collector panel, which was too far. We moved it to where the pipe enters the collector, so it would sense the heat coming from the panel. It must not be inside the collector panel because of extreme heat that could damage the sensor, but it had to be as close to the panel as possible.

The sensor on the outlet pipe of the circulating water tank was also poorly located, so we moved it on the inlet pipe of the second stage of the heat exchanger. This change was necessary because the circulating water gets too hot too quickly and the signal to shut of the circulating pump was generated. With the change, the temperature of the stored water has to be close to that of the collector water temperature for the pumps to shut off.

During the investigation of the system, we noticed something else. The circulating water storage tank, being non-pressurized, is permitted automatic drain back from the panels. Therefore, in case of a power failure or temperature being too low, the solar collectors drain back automatically.

The solar controller has a protection circuit that shuts off the sytem if the outside temperature gets to 2°C. If this circuit fails there are two temperature bulb sensing switches hooked up in series with this circuit. We found both those switches to be defective. We changed them.

While waiting for the data aquisition equipment last summer, we operated the solar energy system on automatic. We found it to be very efficient, reaching temperatures, at times, of up to 50° - 52°C. We noticed the boilers ran very little during the day. Even in very nice sunny winter days the system will come on and help save energy.

If our reservoir tanks and circulating water tank were insulated we could reach even higher temperatures and in very little time we would recover the cost of insulating.

We believe that this is a very efficient energy saving system and are anxious to have all data recorded to measure energy savings.

COST/BENEFIT ANALYSIS

The original approved budget was $246,500.00. Ten thousand dollars were later added for the monitoring system. We have exceeded the budget by $57,370.00.

The total project cost was $313,870.00 and these were the variances with the budget:

	Budget	Actual	Variance
Design	$ 5,000	$ 6,890	$ (1,890)
Purchase Material	119,580	182,857	(63,277)
Installation	58,000	39,694	18,306
Monitoring Equipment	24,150	43,392	(19,242)
Management & Reporting	14,000	12,425	1,575
Data Collection	6,000	4,200	1,800
Info Transfer	4,000	3,241	759
Final Reporting	5,770	1,025	4,745
Contingency	20,000	20,146	(146)
	$256,500	$313,870	$(57,370)

Fuel Consumption

Looking back over a period of three years, we can appreciate that big savings will be made with the solar system.

Taking 1982 as a base, the year prior to operating the solar system, we can confirm major savings even though the system was not in full operation.

At today's price, the following savings were made:

Year	Fuel Consumption (litres)	Based on Jan./85 Prices
1982	312,488	103,121
1983	278,657	91,957
1984	252,900	83,457

We noticed that fuel consumption went down by 10.87% and then 9.24% for a total of 19.07%.

The average annual saving, since the operation of the system is $9,832. There is no doubt in our minds that the savings will be greater in 1985 now that the system is operating automatically on a permanent basis.

Payback Period - Total Project Cost

Based on two years of operation an annual saving of $9,832 has been realized. This saving exceeds the estimated annual saving by 18.2%. But due to the increased cost the payback for the entire project has increased to 32 years.

We are convinced that the savings will be greater and the payback period will be shorter.

Payback Period - Capital Cost Only

The total capital cost of the solar project is $177,627.00. The capital cost includes:

Solar panels - collectors	$ 82,025
Collector racks	6,000
Pipes, valves	27,551
Pumps	6,000
Tanks	28,751
Heat exchanger	6,500
Insulation	20,800
	$177,627

The payback period on the capital cost is 18 years based on two years of system operation. This is a 20% decrease from the estimated capital cost payback period of 22.7 years.

We are very anxious to see the 1985 savings and even more the savings in the next five years. The system has demonstrated that substantial savings can be obtained with solar energy, and this observation can be made after only two years of operation on a temporary basis.

CONCLUSIONS

The initial objectives of the project were to demonstrate that solar energy could be used to reduce the cost of heating domestic hot water in a large nursing home located in the Atlantic Provinces. Several factors were taken into consideration before the project was undertaken:

1) The difficult climate of the area, long winters, limited days of sunshine near the Atlantic Coast.
2) The system would be the first of this type located in the area.
3) The rising price of oil.
4) A 200-bed nursing home with incontinent patients and a laundry would use a large volume of hot water.
5) Domestic hot water would take advantage of the long sunny days of summer, not required for space heating.

Although we are confident the initial objectives will be met and even surpassed, many difficulties were encountered which had not been anticipated.

One of the first difficulties came early. We had selected an out-of-Province designer. This decision was made because of their substantial experience in the field of solar energy. The decision proved both beneficial and problematic.

The experience and knowledge of the designer was helpful in determining the original concept, planning its adaptation to our existing facilities and in the preparation of our submission to the Energy Secretariat.

One of the main concerns with having an out-of-Province designer is distance. If a problem arises, it is very difficult to solve it by telephone or correspondence; it is also very expensive to pay air travel, motel and time to an Engineer from Montreal or Toronto.

A local contractor with limited experience with a new concept is often obligated to proceed by trial and error, if errors were made in the design. These types of problems were encountered and changes in design were made on site. The result is a system which is substantially different from the original design. It has also meant purchase of new equipment not included in budgets.

The original design showed three (3) expensive pumps to circulate water to the collectors and through the heat exchanger, and from the storage tanks through the heat exchanger. This caused many problems and experimentation before the system could be properly balanced.

The result of these experiments proved that the system works more efficiently with one pump, that one should be left as a stand-by and the other pump could be eliminated.

The monitoring system was not included with original plans and had to be designed and adapted after the system was installed.

To provide necessary data required for the demonstration project, water meters had to be installed. They were not included in the design or the budget.

Because of the problems enumerated above, the system was installed on an experimental basis. This required over four years of trial and error, instead of the two years originally expected. This has incurred some additional cost which had not been provided for in the pro-formas.

We would like to acknowledge the co-operation and support received from the N.B. Energy Secretariat.

The project was originally under the supervision of Mr. Dan Clark, P. Eng. and later continued with Mr. Tom Sisk, P. Eng.

We appreciate the time and efforts provided by these two government officials and their staffs.

RECOMMENDATIONS

The first recommandation we would make before undertaking a similar project would be to give sufficient attention to the following points:

1) Try to find a designer from the same Province or the nearest city, if possible; make sure they are responsible to design the complete system, including installation procedures, location of sensors, meters, pumps, etc; make sure that adequate number of inspections are included with the design fees.

2) If the system does not function properly when built according to design specifications, ensure that the designer will be required to make special on site inspections at their own cost. These inspections would not reduce the required progress inspections mentioned above.

3) Special provision should be made in the budgets for changes in plans necessary to correct design errors or impractical design concepts.

These recommendations are offered as constructive suggestions and do not limit the value of the project as it exists today. We are convinced that any similar project would be worthwhile and efficient in reducing the cost of energy.

ACKNOWLEDGMENTS

Because the designers of the project, Petro-Sun of Montreal, were so far from the project, its was necessary to use local resources to eliminate some of the smaller problems or to "de-bug" the system.

Their contributions have been invaluable and are acknowledged below.

Aldor LeBlanc
Project Manager

Contributors

Petro-Sun - Engineers
René N. LeBlanc - Architects
Blair's Plumbing - Contractors
J.C. Belliveau - Physics Teacher
Gilles LeBlanc - Industrial Engineer
Yvon Belliveau - Civil Engineer

SUPPORTING MATERIAL

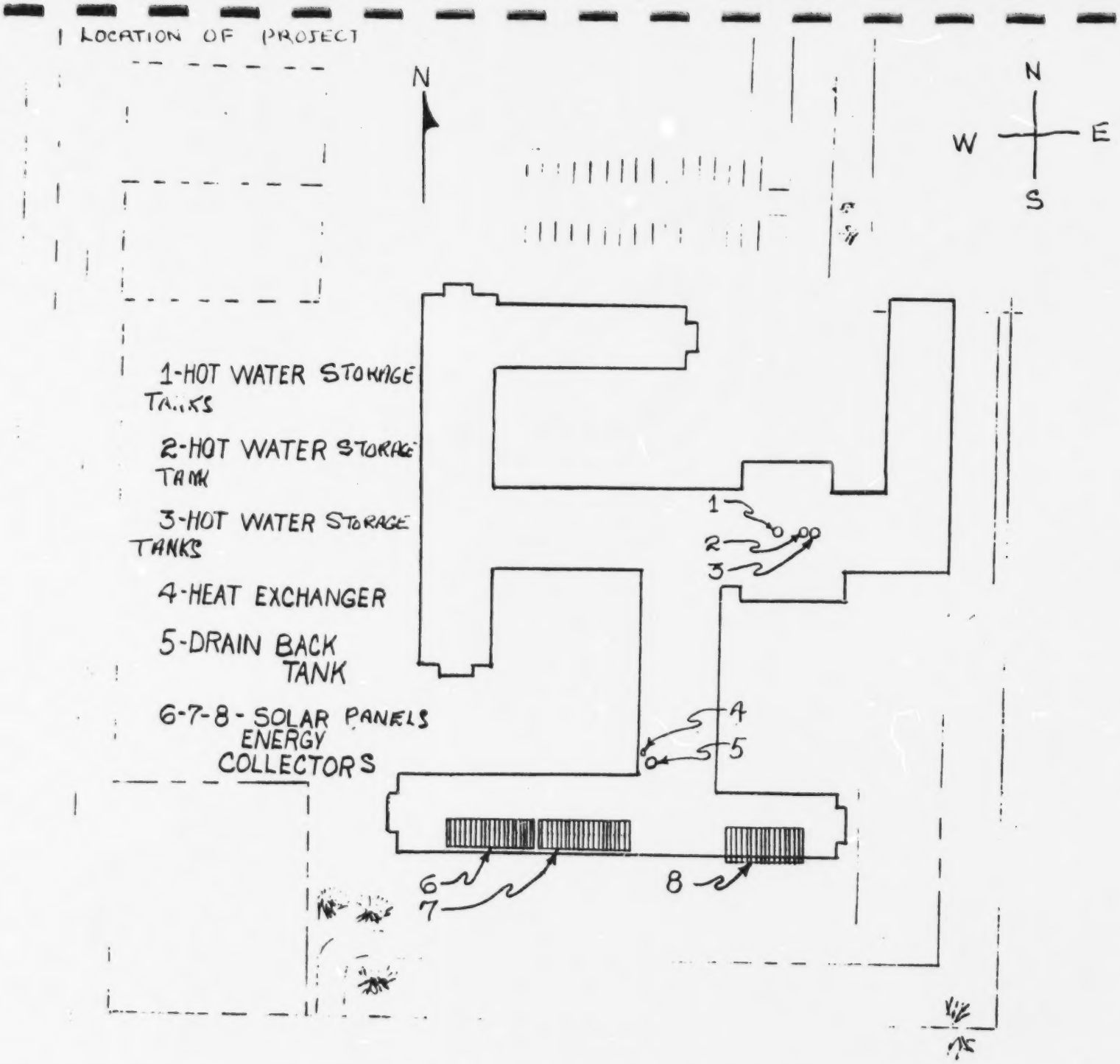
1. Plot plan showing location of project
   Domestic hot water solar heating system (plan)

2. Plan - Solar Water Heater

3. Monitoring system - description

4. User's Guide to ISAAC 91A

5. Manufacturer's information sheets
   - Thermo Solar Collectors (Petro-Sun)
   - Commercial Solar Controller Model TS-1000 (Petro-Sun)
   - Installation Instructions - D4 Polyphase Meter
   - Type S Green Seal Meters
   - Color Display - Model CM-1481 (Hitachi)
   - Series A19 Temperature Controls for Refrigeration (Johnson Controls)
   - Neptune 1/8", 3/8" and 3/4" VLF Meters (for low flow)


LOCATION OF PROJECT
N
N
W
E
S
1-HOT WATER STORAGE TANKS
2-HOT WATER STORAGE TANK
3-HOT WATER STORAGE TANKS
4-HEAT EXCHANGER
5-DRAIN BACK TANK
6-7-8-SOLAR PANELS ENERGY COLLECTORS
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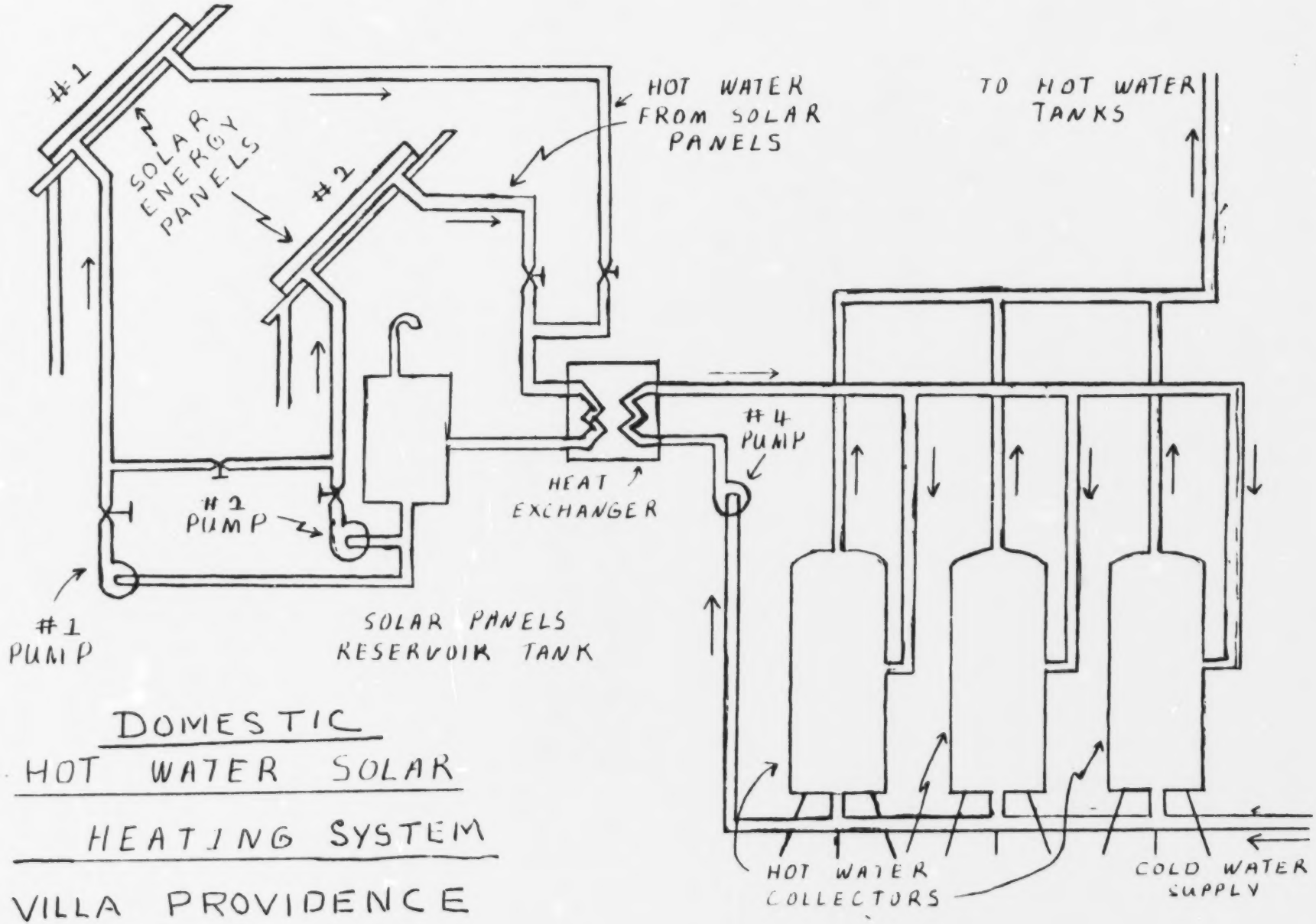
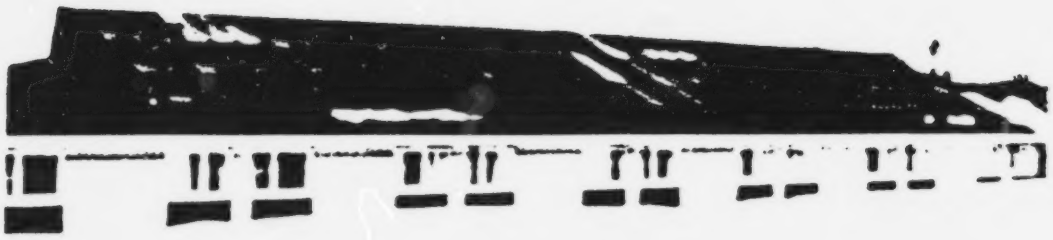
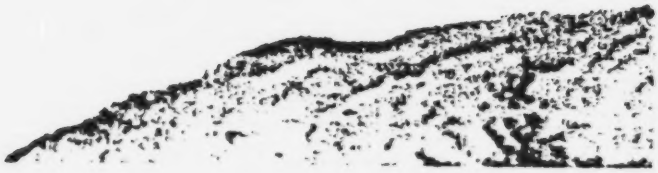
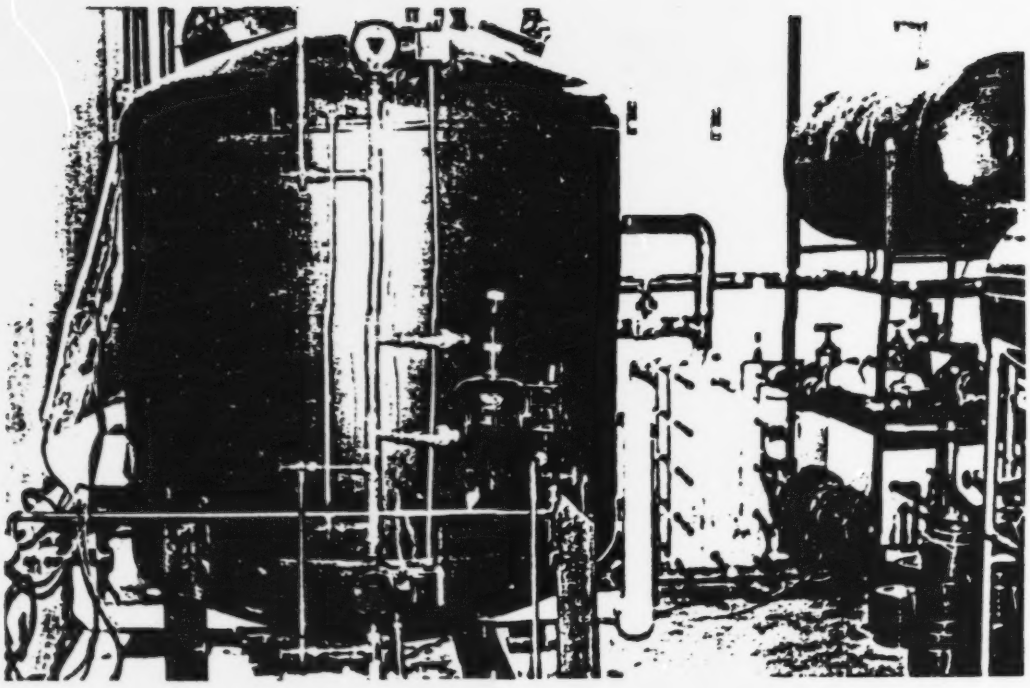


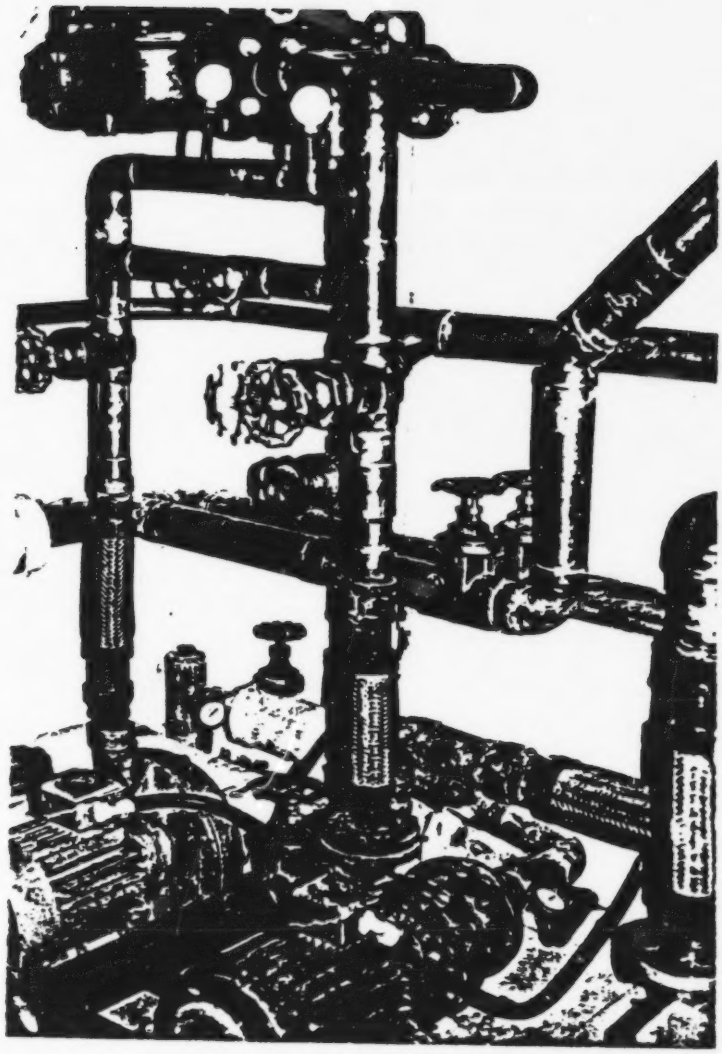
DOMESTIC HOT WATER SOLAR HEATING SYSTEM

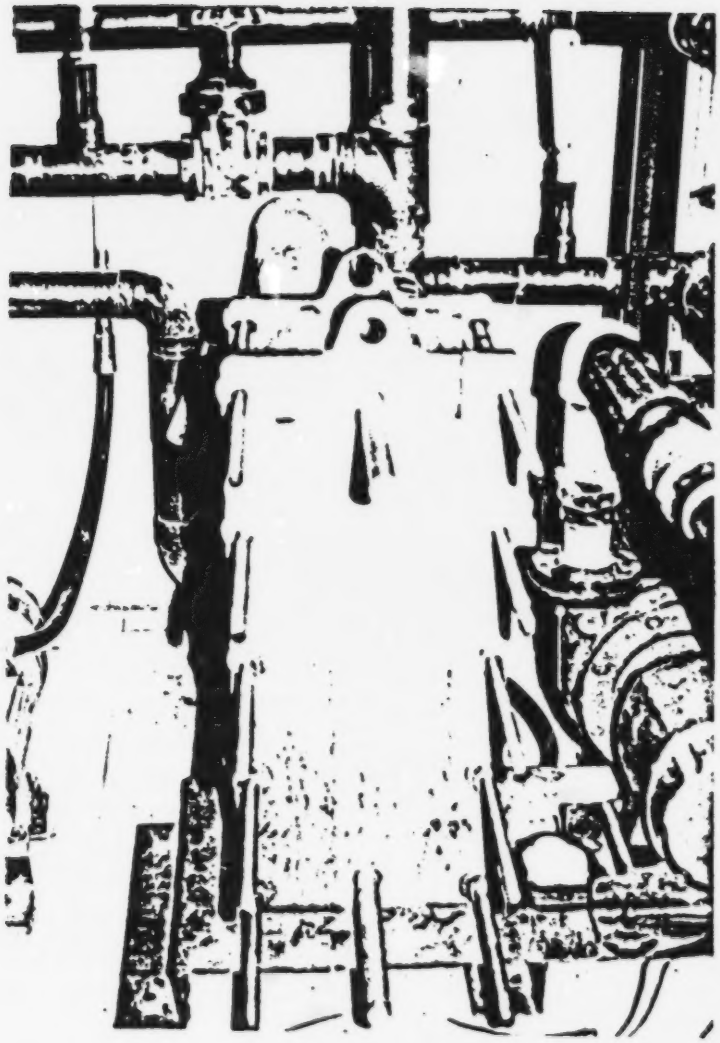
VILLA PROVIDENCE
SHEDIAC N.B.







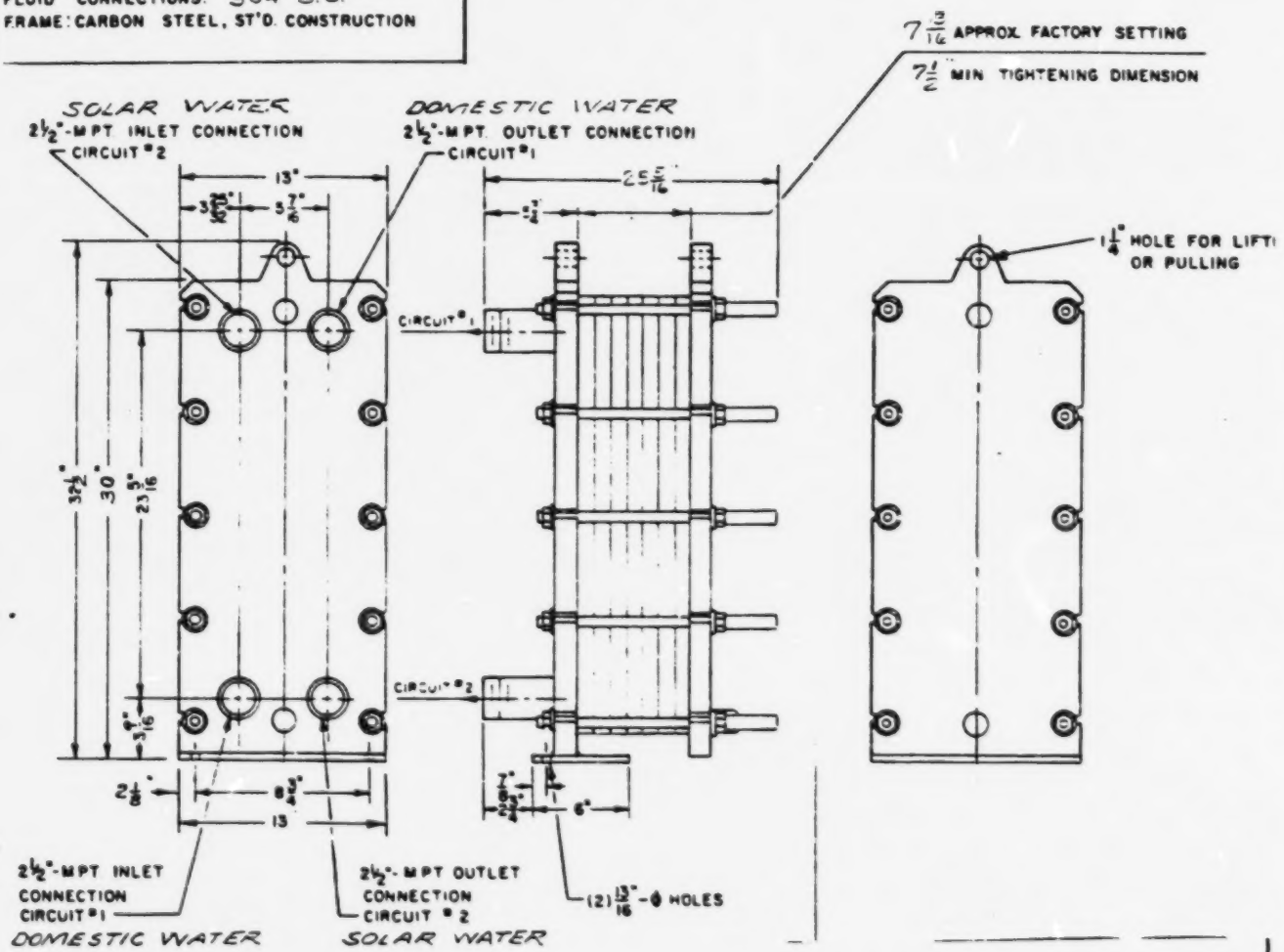




CAPACITY: TO HEAT 150 G.P.M. OF DOMESTIC WATER (CIRCUIT #1) FROM 96 °F TO 101 °F WITH 165 G.P.M. OF SOLAR WATER (CIRCUIT #2) IN AT 106 °F. AND OUT AT 101.4 °F.
CLEANLINESS FACTOR: 89.5 %
HEAT LOAD: 379,798 BTU/HR.
PRESSURE DROP CIRCUIT #1: 10 PSI
CIRCUIT #2: 12 PSI
EFFECTIVE SURFACE: 659 SQ. FT.
1 - PASS DESIGN

MATERIALS OF CONSTRUCTION

HEAT EXCHANGER PLATES: 304 S.S.
GASKET MATERIAL: NITRILE
FLUID CONNECTIONS: 304 S.S.
FRAME: CARBON STEEL, ST'D. CONSTRUCTION



FOR VILLA PROVIDENCE
SHEDIAC, N.B. CANADA

SOLAR WATER HEATER
P.O. #459752

CERTIFIED CORRECT
J. R. Mathieson
DIRECTOR OF DRAFTING

NATIONAL BOARD REGISTRATION

A S M E (1980) CODE CONSTRUCTION WITH INSURANCE COMPANY CERTIFICATE AND STAMPED AS FOLLOWS

PRESSURE DATA		
DESIGN TEMP.	DESIGN PRESS.	TEST PRESS.
200 °F	150 PSI	225 PSI.

P.K. PLATE & FRAME HEAT EXCHANGER
MODEL HX-12D-53-L2-1-PASS

PATTERSON-KELLEY CO.
Div. of HARSCO Corporation
EAST STROUDSBURG PA. 18301

	BY	DATE	FILE SIZE	REFERENCE NO. 264440
DRAWN	[illegible]	9/25/81	C	C-64156
CHECKED	BCW	9/29/81		
APPROVED				

MONITORING SYSTEM

VILLA PROVIDENCE SHEDIAC INC.

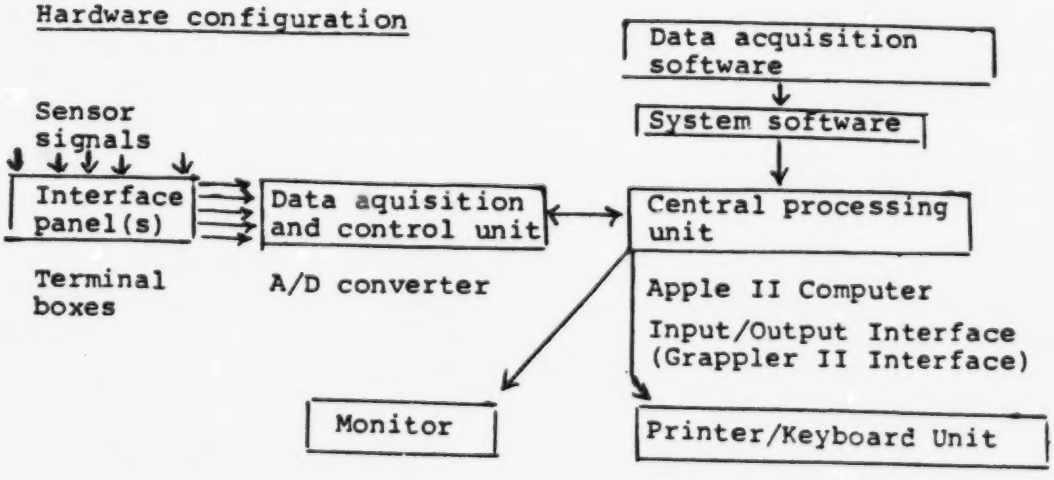
Data Aquisition System - The data collection process will be computerized. The raw data are processed into engineering units and reduced to hourly results. By doing this, data volume is reduced and is in a useful format.

Hardware System

The system consists of four main components:

1) the sensors, which generate an electric signal in a known relationship to the parameter being measured;
2) the interface unit, which converts the signals to digital values that can be read by the computer;
3) the central processor (or computer), which monitors the sensors, reads the data, performs arithmetic functions, and generates accumulated results in engineering units;
4) output devices to store and/or display the results.

Hardware configuration



Software System

The data ^aquisition software can be purchased as computer programs and modified to suit our needs.

System Overview

The incident solar energy will be detected and measured using a pyranometer. The readings will be taken at the desired intervals.
BTU's produced by the collector will be found by measuring the inlet and outlet temperatures of the collector fluid and using the following equations. The measurements will be taken continuously using a flowmeter.

Equations

I. Energy required each month to meet the hot water load is given by:

$$L_{DHW} \text{ (BTU's / month)} = (G) \frac{\text{gallons}}{\text{day}} \times (10) \frac{\text{lb}}{\text{gallon}} \times (1) \frac{\text{BTU}}{\text{lb} - {}^{o}\text{F}}$$

$$\times (T_{set} - T_{M})\,{}^{o}\text{F} \times 30 \frac{\text{days}}{\text{month}}$$

Tset = is the set temperature of the hot water desired in ^{o}F Ex. $140^{o}F$ (sensor)

T_M = temp of cold water entering the system from water main in ^{o}F Ex. $52^{o}F$ (average monthly sensor)

G gallons/day of hot water used
1. meter for water main
2. meters of hot water line
(one on laundry side M_2
(one on potable side M_1

NOTE: Check if T_M is same for potable water & laundry.

II. Energy supplied by solar heating system

i) Q_{ONW} by solar - Laundry $= G_{Laundry} \times 10 \times 1 \times (t_{read} - T_M) \times 30$ in both =

ii) Q_{ONW} by solar - potable = $G_{potable}$ x 10 x 1 x (Tread - T_M) x 30 = in both

III. Calculate load fraction F (by solar)

BTU's drawn from storage tank will be computed as for the collector.

Energy provided to the auxiliary heater will be meaured directly as for the collector.

Temperatures of the outside ambient and the storage tank will be taken and recorded hourly.

The hours of operation of the collector circulating pump will be recorded.

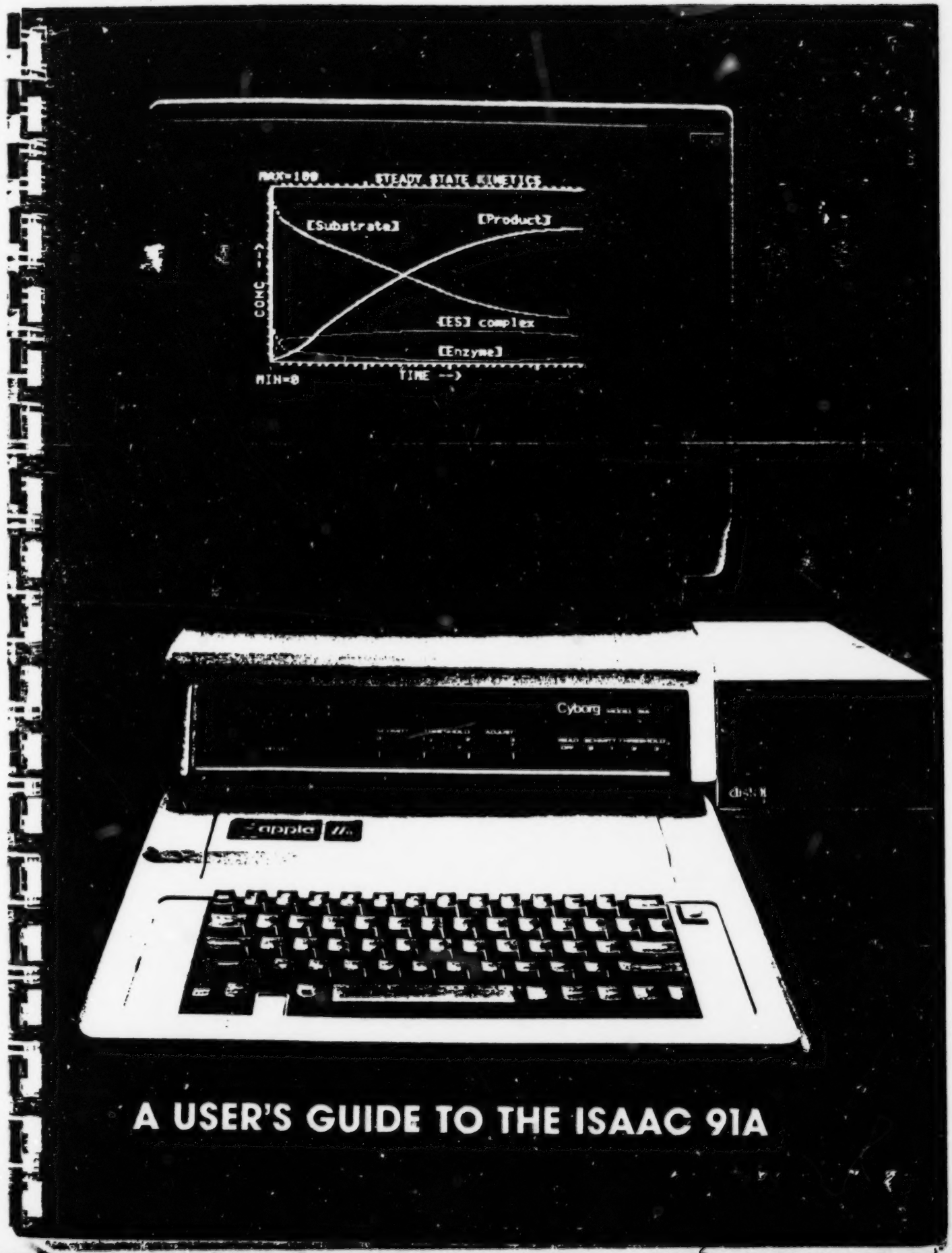
A calculation of solar contribution will be made daily by taking the ratio $\frac{Q_s \text{ (Solar energy delivered)}}{Q_t \text{ (Total energy delivered)}}$

Monthly Report - Ambient temperature - hourly
Incedent solar energy - hourly
Collected solar energy - hourly
Stored solar energy - hourly
Solar energy delivered - hourly
Total energy delivered - hourly

Report in table form.

Equipment required and estimated cost:

1.	Flow meters	$ 2,900.00
2.	Sensors	800.00
3.	Data aquisition , storage and Control system FL -8349-00 Data logger Apple IIe, Printer,Grappler II and Monitor	3,600.00 4,000.00
4.	Multiplexer	1,200.00
5.	Installation & Wiring	2,000.00
6.	Software	1,000.00
7.	Pyranometer and Misc.	2,000.00
8.	Other - Specialized Technical	4,000.00
9.	Unforeseen	2,000.00
		$ 23,500.00



A USER'S GUIDE TO THE ISAAC 91A

INTRODUCTION

Congratulations on your purchase of ISAAC, the Integrated System for Automated Acquisition and Control. Cyborg Corporation has been in the data acquisition business for over a decade, and was among the first to extend the power and flexibility of the Apple II microcomputer to laboratory automation. Your ISAAC 91A system incorporates Cyborg's years of experience with data acquisition and the Apple II. We are confident that your ISAAC will serve you well.

The typical ISAAC 91A system includes:

- An ISAAC model 91A
- The **LabSoft** data acquisition programming language
- ISAAC/LabSoft documentation
- An Apple IIe microcomputer
- Two disk drives (2nd drive optional)
- A color monitor
- Optional dot matrix printer

The ISAAC/LabSoft/Apple system provides:

- An easy-to-use powerful data acquisition programming language
- Easy conversion of analog and digital signals into Apple-compatible information
- Several methods of real-time data display
- Disk storage of data for future use
- Software-controlled analog and digital outputs
- Extremely stable source of reference voltage
- Four adjustable-threshold Schmitt triggers
- On-board, high-resolution timer
- On-board, high-resolution counter
- Calendar/clock with battery backup for continuous real-time control of processes and automated time/datestamping of data

ISAAC represents the first truly personal laboratory automation system for the scientist, engineer and researcher. A fully integrated package of versatile I/O hardware and a powerful, high-level language, ISAAC and LabSoft allow the implementation of complex data

acquisition and control programs with minimal effort.

Your system is fully supported by Cyborg's Technical Support Department. A newsletter is published periodically with system tips and techniques, application notes, new product announcements and news from other users.

This User's Guide will take you step-by-step through the use of your ISAAC system. If you are already familiar with your Apple and Applesoft BASIC, you're ready for this Guide. If not, please start with the Apple documentation and come back to this Guide when you are comfortable with your Apple.

Once the User's Guide has familiarized you with your ISAAC system, the ISAAC 91A Hardware Reference Manual (versions 1.2 and up of this volume are known as the ISAAC 91A System Reference Manual) and the LabSoft Reference Manual will provide you with more detailed information. In addition, you'll find a handy, pocket-sized LabSoft Quick Reference Guide in the LabSoft Reference Manual notebook. This guide lists all of the LabSoft commands and parameters, as well as error codes, color numbers, and other often-needed information.

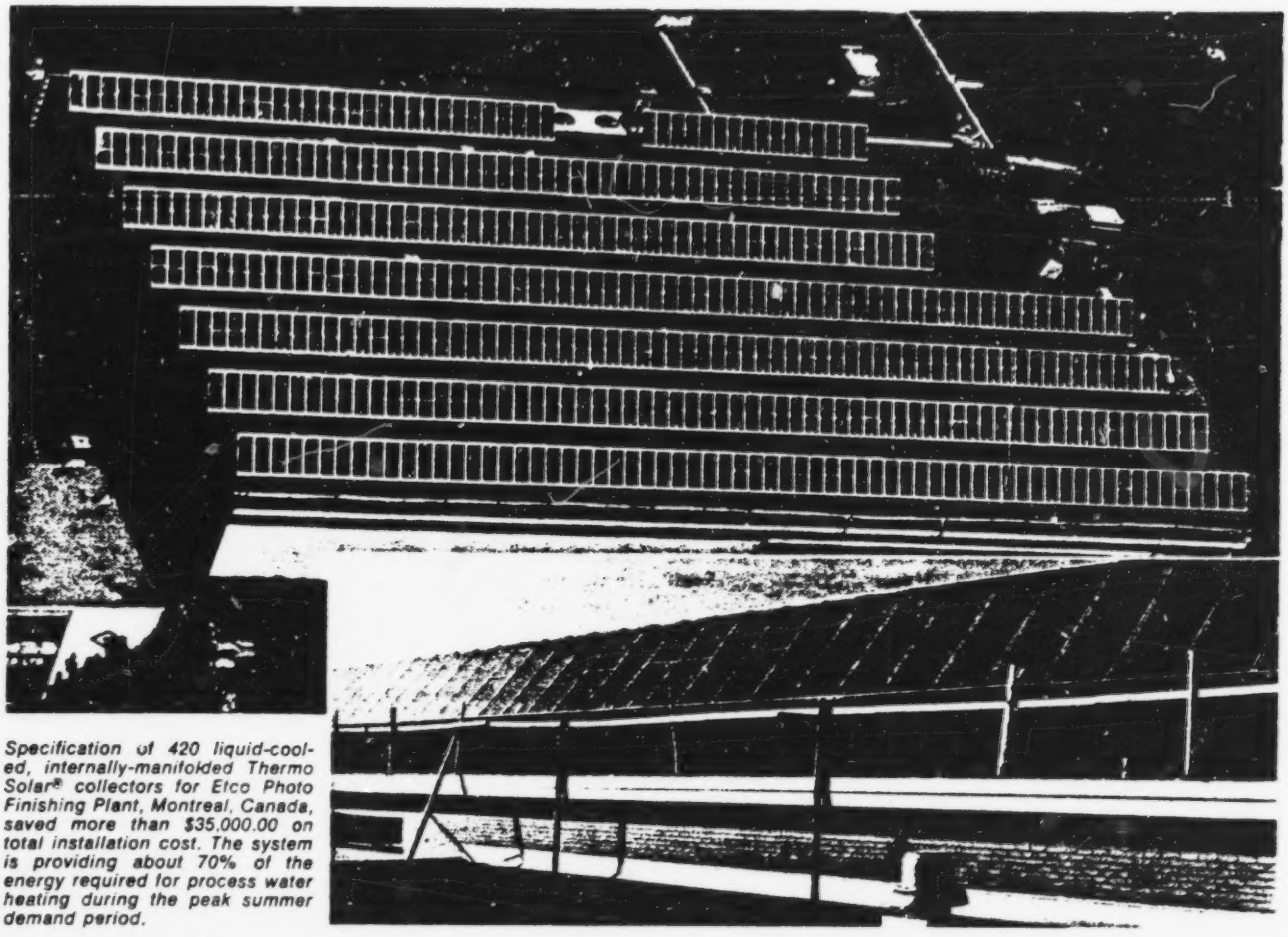
Cyborg Corporation would like to welcome you to its family of satisfied customers. We look forward to hearing from you as you progress with your ISAAC system.

&&&

PETRO-SUN INC.

Thermo Solar Division

- *THERMO SOLAR® COLLECTORS FOR SYSTEMS DESIGNED TO PROVIDE ENERGY FOR WATER HEATING, SPACE HEATING, AND/OR AIR CONDITIONING.*
- *THERMO SOLAR® DOMESTIC HOT WATER SYSTEMS.*



Specification of 420 liquid-cooled, internally-manifolded Thermo Solar® collectors for Etco Photo Finishing Plant, Montreal, Canada, saved more than $35,000.00 on total installation cost. The system is providing about 70% of the energy required for process water heating during the peak summer demand period.

Thermo Solar is a division of Petro-Sun Inc., a publicly owned company also involved in oil and gas exploration activities. Petro-Sun, as a pioneer in the solar industry, is now a leading Canadian supplier of solar energy equipment throughout the world.

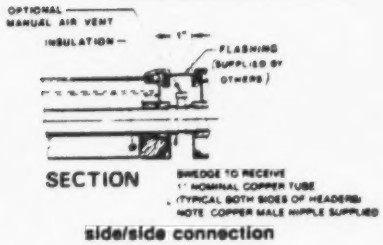
Our Thermo Solar® collector is specially designed to maximize BTU's generated per dollar of installed cost, and our solar-experienced architectural engineering staff offers Collector specifiers valuable help with system design, including computer simulations of collector performance, systems sizing, and return-on-investment analysis.

Our field representatives are experienced HVAC manufacturer's representatives, who have undergone specialized training at the Petro-Sun manufacturing facility. To contact your representative, write or call:

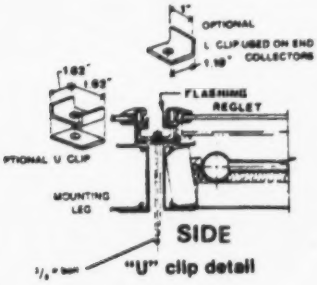
Petro-Sun Inc., 2015 Pitfield Blvd., St. Laurent, Que., Can. H4S 1L8 Tel.: (514) 337-2264 Telex 05-25686

THERMO SOLAR® INSTALLATION DETAILS AND PRODUCT DATA

IM, LC
Internally manifolded, liquid cooled for closed loop systems

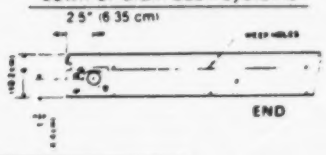

OPTIONAL MANUAL AIR VENT
INSULATION
FLASHING (SUPPLIED BY OTHERS)
SECTION
SWEDGE TO RECEIVE 1" NOMINAL COPPER TUBE (TYPICAL BOTH SIDES OF HEADER) NOTE COPPER MALE NIPPLE SUPPLIED

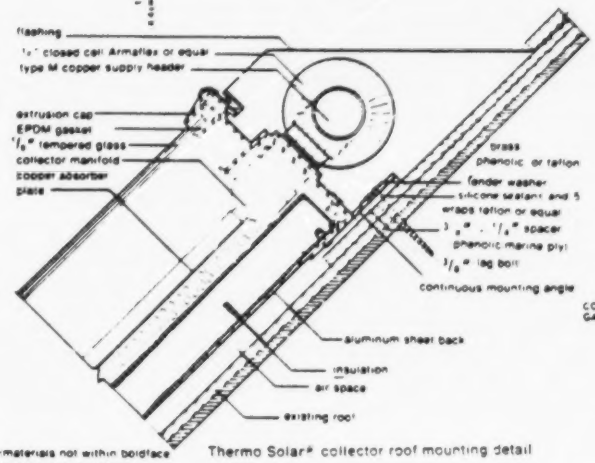
side/side connection



"U" clip detail

EM, LC
Externally manifolded, liquid cooled for drain-down or drain-back systems

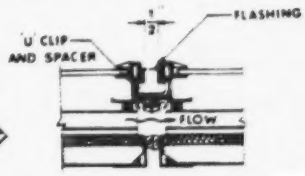




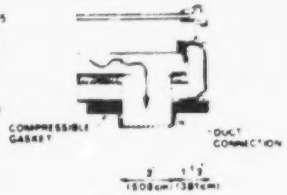
(materials not within boldface line supplied by others)

Thermo Solar® collector roof mounting detail
No scale

ID, AC
Internally ducted, air cooled for warm air systems



SECTION
side/side connection



rear duct connection

DESIGN PARAMETER	IM, LC	EM, LC	ID, AC
DIMENSIONS (OUTSIDE; SURFACE MOUNTED)	35½" (90.2cm) wide x 84" (213.4cm) long x 4" (10.2cm) thick. Add 1¼" (3.2cm) each end for continuous mounting leg.		
MANIFOLDS AND RISERS (LIQUID COOLED COLLECTOR)	1" type M copper manifolds. Brazing alloy connections to riser tubes. Risers in parallel grid pattern, high temperature solder bond between tube and absorber sheet with 270° wrap.		not applicable
Riser spec.:	¾" (0.95 cm) O.D., type L copper		not applicable
WEIGHT PER MODULE	107 lbs. (48.5 kg) filled; 104 lbs. (47.2 kg) empty for standard 3' x 7' unit.	98 lbs. (44.5 kg) filled; 95 lbs. (43.1 kg) empty for standard 3' x 7' unit	112 lbs. for standard 3' x 7' unit
	Add 32 lbs. (14.5 kg) for double glazed unit. Liquid in Solector: 0.48 gal. (1.82 l)	0.36 gal. (1.4 l)	137 lbs. for double-glazed unit
RECOMMENDED FLOW RATE	13-26 lbs/ft²/hr (0.5-1.0gpm; 0.032-0.063 l/sec)		3-5 cfm/ft² of collector
EXTERNAL CONNECTIONS	1" type M copper tube. Ends can be capped, or routed out back, top, or bottom as required.	1" type M copper tube, extending 1⅞" (4.76cm) beyond collector frame; supply, bottom left; return, top right (when viewed from glazing side)	side/side compression gasket and/or back inlet/outlet rigid duct connector.
COVER	Tempered glazing, edges swiped; glass area 18.88 ft² (1.76 m²); condensate removal via weep holes		
	Low-iron ⅛" (0.32cm); Solar transmissivity 89.8%, double glazing 80.6%. No-iron ⅛" (0.32cm), solar transmissivity 91.6% avail. as special order.		Low-iron, ⅛" (0.32cm); solar transmissivity 89.8%, double glazing 80.6%
ABSORBER CONTAINER	Sides, 6063-T6 aluminum extrusion, standard mill finish; baked black enamel as special order		
	Back, aluminum sheet 0.032" (0.081cm), pop rivet to extrusion. Air space between cover and absorber approx. ¾-1", depending on glazing type.		Back, aluminum sheet 0.32" (0.081cm) pop rivet to extrusion. Air chamber ⅞" (2.22cm) high, silicone bonded aluminum core to absorber.
ABSORBER	Copper sheet, 0.010" (0.25cm) thick (7 oz.). Black chrome coating, min. absorptivity .94/.96, max. emissivity .08/.12		Copper sheet, 0.016" (0.04cm) thick (12 oz.). Selective black coating, min. absorptivity 0.87/0.92, max. emissivity 0.07/0.35. Proprietary process guaranteed durable to 400°F (205°C)
EFFECTIVE ABSORBER AREA	18.50 ft² (1.72 m²)	18.68 ft² (1.74 m²)	
USABLE ABS. AREA ÷ TOTAL INSTALLED SURFACE	0.89	0.90	

Note: For liquid coolant, Aquasol-60, made by Petro-Sun (data sheet available on request), or equivalent, is recommended. In areas where regular tap water is used, pH should be between 6.5 and 8, and CaMg count below 50ppm.

PETRO-SUN INC.

We believe the Thermo Solar® collector offers the lowest cost/Btu/ft² installed in the industry.

Excellent thermal performance

- proven effective and efficient in over five years of field experience and numerous independent testing programs.
- selective black or black chrome coatings for copper absorber plate maximize absorptivity and minimize emissivity of solar radiation.
- absorber and external connections thermally isolated from remainder of collector.
- high transmissivity, tempered glass cover sheet.
- weathertight container, with built-in thermal expansion features.
- built for long term durability and reliability; backed by five-year materials and workmanship warranty.

Optimized solar system efficiency and total contribution

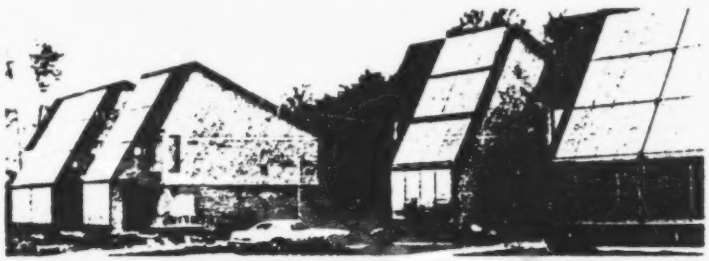
- high installed net-to-gross ratio; about 90% of total surface covered by collectors is usable absorber area.
- internal manifolding or ducting option significantly reduces costs for materials and labor during installation, while maximizing the number of collectors that can be placed in a given area.

Highly adaptable in application

- variety of liquid and air-type panel designs and connection arrangements allow for coupling in parallel or series, and to suit varying system designs.
- suitable for domestic/service water heating and space heating/cooling for commercial, industrial, institutional, and residential buildings, as well as for industrial process heating, low-temperature steam production, and special drying applications.

Easy and economical to install and maintain

- patented snap-in flashing reglet around entire frame permits easy flashing without removal of cover glass; cover may be removed later without disturbing collector unit installation or flashing. Entire collector modules may be removed without disturbing adjacent modules.
- continuous mounting flange, integral with frame across top and bottom, facilitates installation, especially on residential retrofit applications.
- extrusion that forms the frame allows for secure anchoring at both ends, minimizing need for further reinforcement to resist wind loads.
- manifolds pitched in liquid-type collectors for rapid draining, and elimination of air pockets during filling.
- cover glass is swiped to minimize breakage risk. Weep holes allow for draining of condensate.
- absorber floats free on insulation to allow for thermal expansion and contraction.



Town Houses in Laval, Quebec. Both air and liquid-cooled Thermo-Solar® collectors are used to provide about 65% of the energy required for space and domestic water heating.

DESCRIPTIVE SPECIFICATION (Thermo Solar® liquid cooled collector)

13.11a Solar Collectors

A. General

Provide (no.) Thermo Solar collectors by Petro-Sun Inc. as shown on the drawings. Collector installation shall be as per the collector manufacturer's recommendations. Collector shall be designed to withstand 100 mph winds.

B. Collectors

1. **Size:** Each collector shall be 3′ x 7′ x 4″ overall with a net effective area of 18.50 square feet minimum.
2. **Waterways:** All piping shall be of the parallel grid design consisting of ⅜″ O.D. L-type copper tubing on 4″ centers, with 1″ O.D. Type M copper headers. Tubing and headers shall be connected by means of brazing alloy. Manifold and tubes shall be capable of withstanding 250 psig factory test and 125 psig working pressure.
3. **Absorber Surface:** The absorber surface shall be copper sheet 0.010 inches thick, black chrome with a 270° wrap around each tube bonded between tubes and sheet with high temperature solder. Minimum absorptivity shall be .92/.94; maximum emissivity .08/.12 Entire absorber surface shall be guaranteed durable to 400°F.
4. **Absorber Frame:** Frame sides shall be extruded aluminum with a rear aluminum sheet of 0.032 inches minimum and pop riveted in place.
5. **Insulation:** There shall be a minimum of ½″ thick glass fiber, compressed over 1″ thick foil-faced isocyanurate 1.2 lbs. per cubic foot density with an R factor of 10.
6. **Glazing:** The glazing shall be single lo-iron (A.S.G.) ⅛″ tempered, edges swiped.
7. **Sealing:** Gasketing material shall be EPDM "U" closed cell elastomer with a compressible high temperature silicone seal.
8. **Joining:** Collector-to-collector and collector-to-supply and return mains shall be joined with 95-5 solder.
9. **Condensation Removal:** Removal of condensate from the collector shall be via mechanical weeping through frame weep holes.
10. **Serviceability:** Easy removal of each collector is required. Glazing shall be replaceable without removal of collector.
11. **Warranty:** Except for cover glazing, collectors shall carry a five year materials and workmanship warranty from date of installation.
12. **Manufacturer:** Petro-Sun Inc., Thermo Solar Division.

C. Mounting

Collectors shall be mounted in accordance with drawings. Use of integral mounting legs and/or adjustable U-clip and spacer as required. See manufacturer's recommendations.

D. Flashing

Flashing shall be minimum 0.032″ thick aluminum or stabilized C.P.V.C. reglet, stock finished to match collector frame; V-groove for snap-in flashing reglet integral to collector frame. See drawings.

THERMO SOLAR® COLLECTOR PERFORMANCE SPECIFICATION

ıermal Performance

The collector shall be tested in accordance with ASHRAE STD. 93-77 by an independent testing laboratory. The following test results shall be submitted:

a) Raw test data (solar and weather)
b) Instantaneous efficiency equation, employing a second order least squares polynomial fit, and plotted on a graph showing instantaneous efficiency on the ordinate versus (T inlet − T ambient) ÷ Insolation on the abscissa.
c) Time constant
d) Incident angle modifier

ıne instantaneous efficiency, determined by the above test, shall be equal to or greater than that defined by ·· e following six points on the performance curve:

$\frac{T_i - T_a}{I}$	Efficiency (n) (single glazed, %)	Efficiency (n) (double glazed, %)
0.00	73	67
0.10	65	61
0.20	56	53
0.30	50	45
0.40	36	37
0.50	24	27

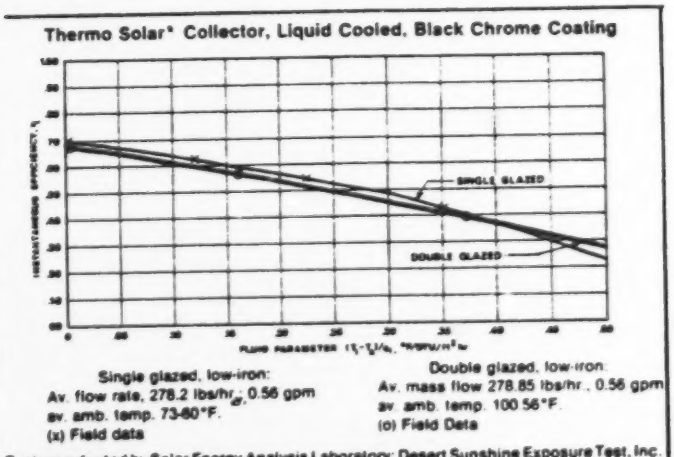
The incident angle modifier shall be equal to or greater than that defined by the following four points:

$\frac{1}{\cos\emptyset} - 1$ (Ø = incident angle)	Incident Angle Modifier single glazed	double glazed
0	1.00	1.01
0.2	.97	.97
0.4	.94	.93
1.0	.86	.81

echanical Performance

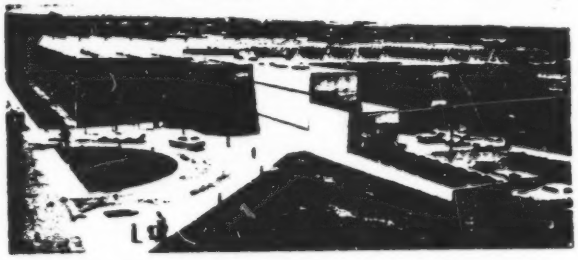
ıe collector, including all materials and components, shall be able to withstand conditions of extended periods of solar flux under stagnant condition. All materials utilized shall be able to withstand temperatures up to 400°F without outgassing or structural deformation. The entire collector shall allow for expected expansion and contraction of various components over temperature range of −25°F to 400°F.

ıe collector shall be able to withstand wind loads up to 100 mph. Piping penetration through the extrusion shall be sealed with a flexible gasket, permitting expansion and contraction while preenting moisture infiltration. The collector shall be hydrostatically sted in the factory to a pressure equal to at least 1.5 times the orking pressure of the solar system.

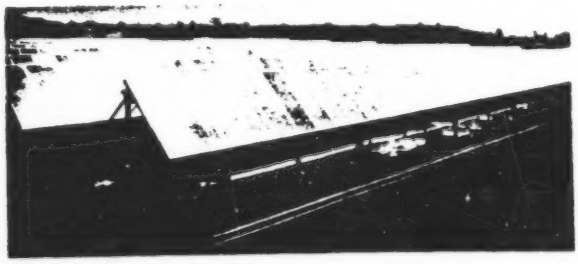

Thermo Solar® Collector, Liquid Cooled, Black Chrome Coating
SINGLE GLAZED
DOUBLE GLAZED
Single glazed, low-iron:
Av. flow rate, 278.2 lbs/hr., 0.56 gpm
av. amb. temp. 73-80°F.
(x) Field data
Double glazed, low-iron
Av. mass flow 278.85 lbs/hr., 0.56 gpm
av. amb. temp. 100.56°F.
(o) Field Data
Tests conducted by Solar Energy Analysis Laboratory; Desert Sunshine Exposure Test, Inc.

he instantaneous (slope - intercept method) thermal efficiency ıest is conducted by maintaining constant mass flow and varying the inlet temperature. The fluid parameter is based on the *inlet* temperature minus the ambient temperature divided by the insolaon incident in the plane of the collector. The thermal efficiency alculation is based on the *gross* collector area (outermost dimensions). Items above are requirements of ASHRAE Standard 93-77 and have a significant effect on the profile efficiency curve. The urve representing most collectors is not linear as suggested by ıe basic slope intercept method. Because the heat loss coefficient ıs temperature dependent, increasing with plate temperature in a non-linear fashion, a higher or second order polynomial is needed to fit the curve to the data. This plotting method has been emloyed in the above curves. This method incorporates all of the rovisions of the ASHRAE 93-77 Method.

Manufactured in Canada



Large commercial Solar System, featuring 467 liquid-cooled internally-manifolded collectors, for Littleton, Colorado Community Center.



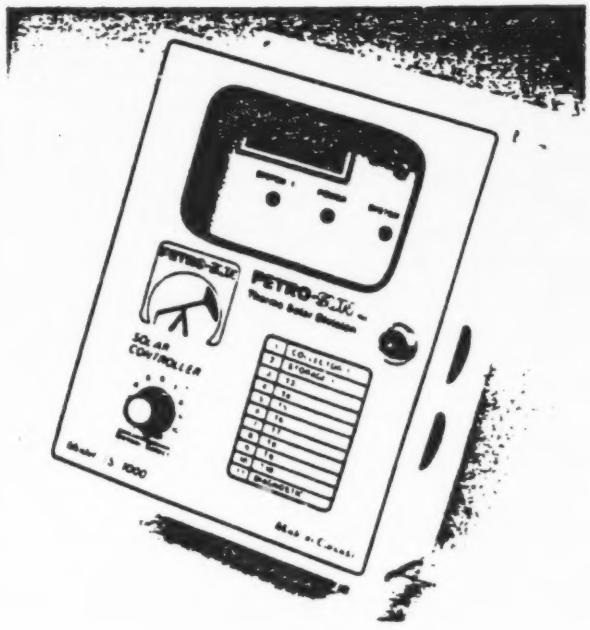
Gaza Food, Montreal, Canada: "Drain-Back" System Featuring 144 Thermo Solar® large Internal manifold collectors.

PETRO-SUN INC.
Thermo Solar Division
2915 Pitfield Blvd., St. Laurent,
Que., Can. H4S 1L6
Tel.: (514) 337-2264
Telex 05-25686

Authorized Representatives:

PETRO-SUN INC
Thermo Solar Division

COMMERCIAL SOLAR CONTROLLER
MODEL TS-1000



The THERMO-SOLAR® Commercial Controller is an industrial quality instrument, designed to control one or two separate commercial solar systems. The Controller is contained in a water-resistant, lockable steel case for safety and durability. This high quality Controller is built to provide years of trouble-free service under commercial use.

FEATURES

— large LED display (selectable in either Centigrade or Fahrenheit)
— normally open or normally closed 5 Amp 24 v relay contacts
— adjustable Delta + and temperature storage limits
— internal self-checking diagnostics
— terminal block wiring connections
— adjustable freeze protection mechanism with either DRAIN (pump off) or RECIRCULATE (pump on)

SPECIFICATIONS

COMMERCIAL SOLAR CONTROLLER
MODEL TS-1000

DESCRIPTION
- size: 9" (220 mm) x 11" (279 mm) x 6" (152 mm)
- approx. shipping weight: 15 lbs. (6.8 kg)
- NEMA 4, water-resistant, lockable steel case
- large 3½ digit display in Centigrade and Fahrenheit
- 4 integrated circuit temperature sensors required
- normally open/normally closed 5 Amp 24v relay contacts
- adjustable temperature controls for ON/OFF and storage high limit
- 10 temperature monitoring positions
- internal diagnostic self-check

OPTIONS
- 6 additional temperature sensors

APPLICATIONS — the Model TS-1000 Commercial Solar Controller is designed to control two completely separate solar systems. It provides differential temperature control for each of two commercial systems simultaneously. Computer compatible pin-outs are provided for use in very sophisticated solar systems.

INSTALLATION — Controller supplied ready for mounting

WARRANTY — 1 year limited

PETRO-SUN INC.
Thermo Solar Division
SYSTEMES ET EQUIPEMENTS SOLAIRES
SOLAR ENERGY EQUIPEMENT

ONTARIO:
5035 Timberlea Blvd., Unit 5
Mississauga, Ontario L4Y 2N5
Tel. (416) 624-5591
Telex: 05-267301

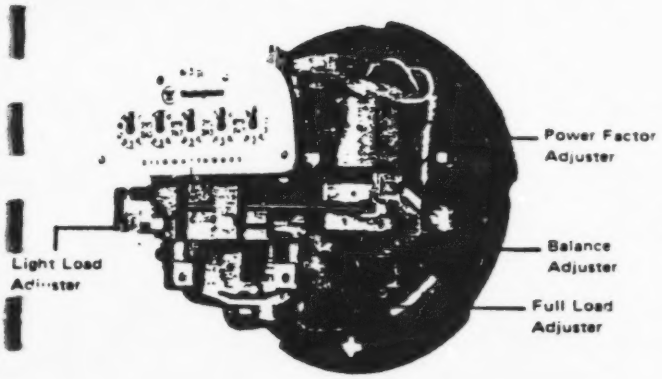
QUEBEC
2915, boul. Pitfield, Ville St-Laurent
Québec H4S 1L6
Tél. (514) 337-2264
Telex: 05 267301

INSTALLATION

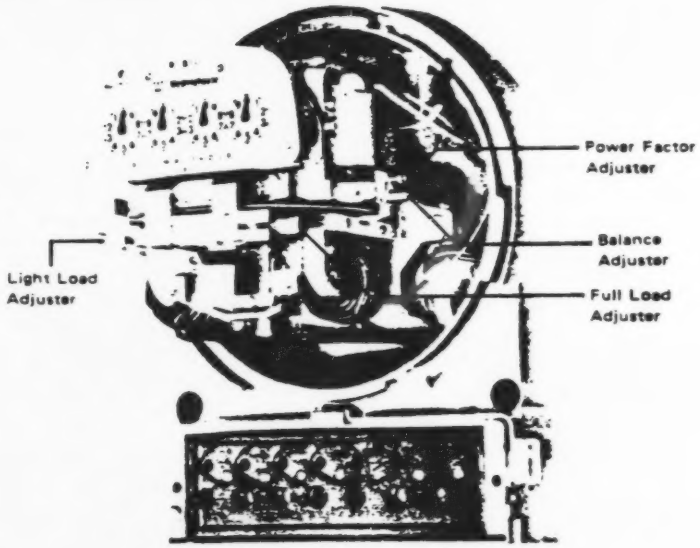
INSTRUCTIONS

D4 POLYPHASE METER
TWO–STATOR
TYPES D4S-2,-5,-7,-8
AND
D4A-2,-7,-8

THREE–STATOR
TYPES D4S–3 AND D4A–3



Type D4S Two-Stator Polyphase



Type D4A Two-Stator Polyphase

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation, or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

NOVEMBER 1977
Supersedes I. L. 42-112 Dated July 1977
And I. L. 42-105 Dated May 1973

D4 POLYPHASE METER

IMPORTANT APPLICATION INFORMATION

TYPES D4S-2 , -3*, -5, -7, -8 AND D4A-2 , -3*, -7, -8
(* – 3-Stator Only)

WARNING

To avoid bodily injury and/or property damage, it is recommended that installation, testing, and servicing be done only by authorized personnel using appropriate installation procedures.

All Westinghouse meters are calibrated and sealed before shipment. The full load operating speed is 8-1/3 rpm, and the watthour constant (Kh) is 1.2 for -2, -5, and -7; and, 1.8 for -3 and -8 per nominal 300-watt rating. For safe installation, good accuracy, and maximum life of the meter, the following procedures are suggested.

Socket-Connected "S" Type Meters

1. Install meter in upright position with rotor shaft vertical and free from heavy vibration.

2. Grounding of meter lightning arrestor ground straps with socket rim should be ensured by scrapping off paint, if any, from socket rim at point of contact.

3. Make certain socket terminal wiring is as shown in appropriate diagrams according to Figures 3 through 31.

4. Meter class rating is the maximum current rating. Meter and socket class rating should be compatible.

CAUTION

Never open the CURRENT CIRCUIT of a transformer-rated meter without FIRST ACTIVATING THE CIRCUIT CLOSING DEVICE TO AVOID ELECTRICAL SHOCK OR BODILY INJURY.

Bottom-Connected "A" Type Meters

1. A reversible meter hanger (per MSJ-10) is attached to the rear of the base and can be adjusted for external or concealed mounting. For concealed mounting, locate and insert in the mounting surface the top supporting screw. A keyhole slot is provided for the supporting screw which should be a size number 12 or larger.

2. A 0.280-inch diameter mounting hole is located on each side of the base just above the terminal block for two bottom supporting screws. Level the meter, insert the two screws, and tighten. The screws should be a size number 12 or larger.

3. An electrical grounding of the meter base is recommended for safety. Attach a number 12 AWG copper wire (or larger) to the external surface of the base by using one of the mounting screws or a self-tapping screw in the base.

WARNING

Grounding should be completed before external connections to the meter are made to avoid electrical shock.

4. All connections to the meter should be made as shown in the appropriate diagrams in Figures 3 through 31. Connecting of accessories are covered by individual instruction leaflets. All connections should be made right-to-left to assure connection of the meter to the load circuit before the line potential is applied.

5. The terminal holes for current leads will accept number 2 (0.292-inch diameter) standard wire. Use proper adapters for larger wire size.

CAUTION

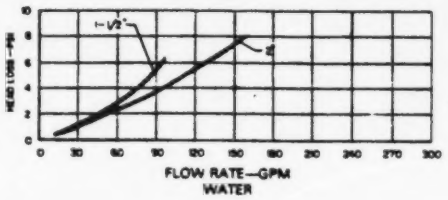
Since the current terminals will only accept a maximum size number 2 conductor, continuous load current from 150 to 200 amperes will require the use of proper adapter or heat sinks to not exceed the necessary standards for maximum operating meter temperature, thereby preventing a fire hazard.

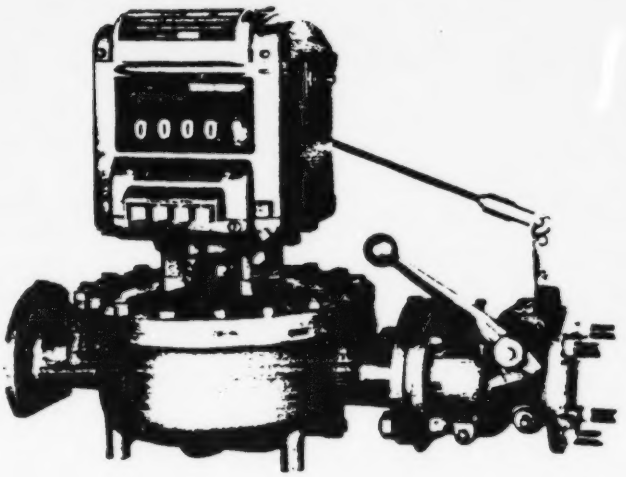
NOTE: For calibration, test, and maintenance information, consult Westinghouse I. L. 42-101.3A. For replacement parts, see Westinghouse RPD 42-112 and RPD 42-105.

TYPE S GREEN SEAL METERS

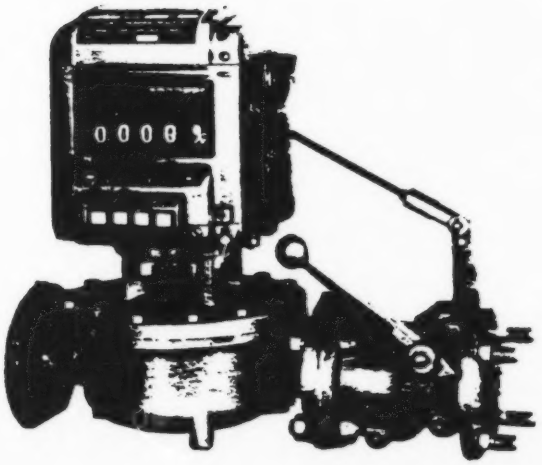
1½ and 2-inch TYPE S

Neptune's 1½-inch and 2-inch Industrial Meters with flow rate capacities of 100 and 160 gpm respectively fill the need for measurement in the medium flow ranges. Their precision manufacture and simplicity of operation make them particularly suited for automatic batching and formula control where accurate mixing of liquid ingredients is required.





2-inch Meter with Model 432 Register and Auto-Stop Valve (single or double trip)



1½-inch Meter with Model 432 Register and Auto-Stop Valve (single or double trip)

FLOW RATE

1½-inch Meter—100 gpm max., 10 gpm min.
2-inch Meter—160 gpm max., 16 gpm min.

WORKING PRESSURE

125 psi max.

TEMPERATURE

250°F max.

CONNECTIONS

Standard flanged ends drilled to match 2-inch ANSI, 4 bolt flanges.
(Order companion flanges separately.)

MATERIALS

Casing, gears, and measuring chamber—composition bronze.
Disk material reinforced synthetic polymer.

REGISTERS AVAILABLE

Type	Register Model	Meter Weight 1½"	lbs. 2"
Totalizer only (not resettable)	157	47	72
Resettable counter with totalizer	431	64	94
with Auto-Stop	432	80	119

FULL FLOW CREST METERS

3, 4 and 6-inch CREST METERS

Green Seal Crest Meters are turbine type Neptune industrial meters. They are used primarily for water and can be furnished to handle temperatures as high as 240°F throughout the recommended range of flow. They are particularly suited for various industrial water operations, such as those found in boiler-water treatment and cement manufacturing.

The Green Seal Crest, featuring a heavy bronze main casing, operates on the velocity principle, with its single, hydraulically balanced turbine being rotated by the water passing through the meter.

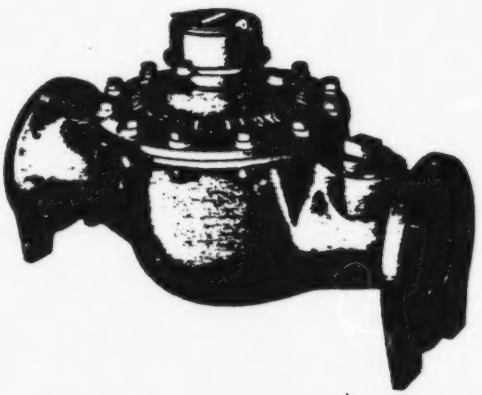
The measuring wheel is molded of a durable, high-impact plastic and rotates on a stationary phosphorbronze shaft. The bushings are graphite. The contoured design of the turbine cage assembly creates a venturi effect and produces axial balance of the turbine rotor. This feature, coupled with the polished jewel thrust bearings at each end of the turbine shaft, ensures turbine sensitivity and reduces wear to a negligible minimum.

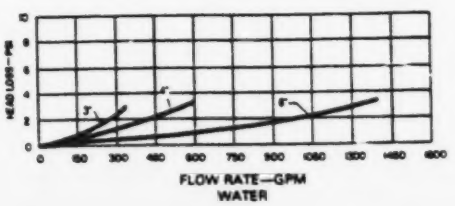
SPECIFICATIONS

FLOW RATE
- 3"—35 to 350 gpm
- 4"—60 to 600 gpm
- 6"—140 to 1400 gpm

OPERATING PRESSURE
- 3"—125 psi
- 4"—125 psi
- 6"—125 psi

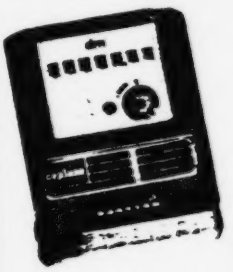
OPERATING TEMPERATURE
- 3"—240°F
- 4"—240°F
- 6"—240°F



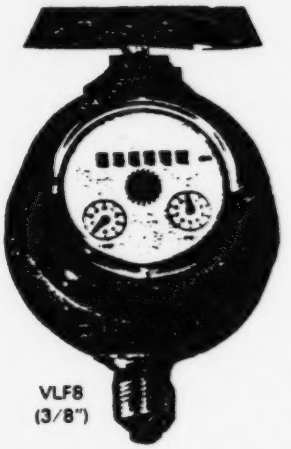


VLF METERS

1/8", 3/8" and 3/4" VLF METERS



VLF4
(1/8")



VLF8
(3/8")

The Neptune line of VLF Low Flow Meters is designed to measure light fuel oil or diesel oil. Offered in three sizes, 1/8", 3/8", and 3/4", flow can be measured at rates from .25 to 390 gph. Accuracy is ± 1%; repeatability, ± 1/4%

The register unit of the VLF8 works accurately in a vacuum sealed casing. It is absolutely secured against dirt, dust and condensation.

The VLF meter can be mounted in any flow direction, but the dial must either face upwards or not more than 90° to one side.

Machined to close tolerances (±.0006), these precision instruments are particularly sensitive to foreign matter. There is a fine filter built into the inlet but, should the liquid being metered contain foreign matter, it is recommended that a screen or removable filter of appropriate size be fitted on the inlet side. The filter mesh should not be larger than 50 micron for the 1/8" and 3/8" meters, or 100 micron for the 3/4" meter.

SPECIFICATIONS

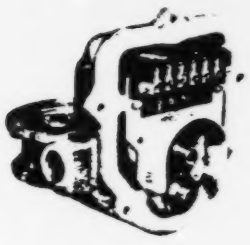
FLOW RATE
- 1/8"—.25 to 8 gph
- 3/8"—1 to 40 gph
- 3/4"—6 to 390 gph

OPERATING TEMPERATURE
- 1/8"—125°F
- 3/8"—140°F
- 3/4"—260°F

OPERATING PRESSURE
- 1/8"—225 psi
- 3/8"—225 psi
- 3/4"—225 psi

DIAL REGISTRATION
- 1/8"—.01 USG
- 3/8"—.01 USG
- 3/4"—.1 USG

PULSE TRANSMITTERS



MODELS 24, 24A, 24B

Neptune Pulsers develop electrical impulses for the actuation of counters, quantity controllers, additive pumps, data collection devices, and other related equipment.

Depending on the size of the meter, on the type of pulser selected, and on the equipment to be operated, the pulser can provide pulses up to 6,000 per minute and can indicate increments as small as one fluid ounce.

Utilizing the rotary motion of the meter mechanism to make or break the switch contact, Model 24 Series Pulsers may be mounted on any meter utilizing a 157 Register by use of a Model 30 Adapter, and on any meter utilizing a 400 Series Register by use of a Model 120 Calibrator/Adapter. Model 24 Series Pulsers may also be mounted to the rear of any 400 Series Register without the use of a 120 Calibrator/Adapter by the use of Flexi-Drive Kit #100442-001.

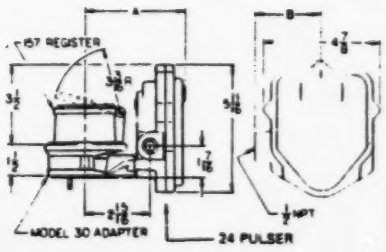
Model 24 Pulsers are mercury-wetted reed-switches with a maximum of 100 pulses per revolution of the input shaft.

PULSER ONLY (MAY BE USED W/ FLEXI-DRIVE KIT)	PART NUMBER*	PULSER W/30 ADAPTER FOR 157 REGISTER	PART NUMBER*	PULSER W/120 ADAPTER FOR 400 SERIES REGISTER	PART NUMBER*
Model 24	(87700-XXX)	Model 34	(87698-XXX)	Model 124	(87699-XXX)
Model 24A	(87700-XXX)	Model 34A	(87698-XXX)	Model 124A	(87699-XXX)
Model 24B	(87700-XXX)	Model 34B	(87698-XXX)	Model 124B	(87699)-XXX)

*Proper suffix numbers determined by numbers of pulses of revolution specified. Consult factory for details.

10 or 100

100-SERIES REGISTERS



MODEL 34 PULSER
(30 Adapter and 24 Pulser)

PULSER WITH Adapter for 157 Register

MODEL	DIM A	DIM B
34, 34A, 34B	5½	3⅛

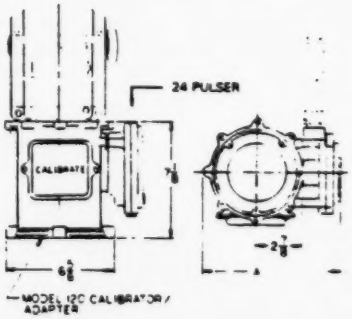
PULSER WITH Calibrator/Adapter for 400 Series Register

MODEL	DIM A
124, 124A, 124B	9¾

When ordering specify:

1. Size & Type of meter (e.g. 1" Type MP).
2. Type register and test hand (e.g. 157, 1 USG, 441, 10 litre).
3. Required pulses per unit (e.g., 1 pulse per gallon, 10 pulses per litre).
4. Model number of pulser and adapter assembly desired.

400-SERIES REGISTER

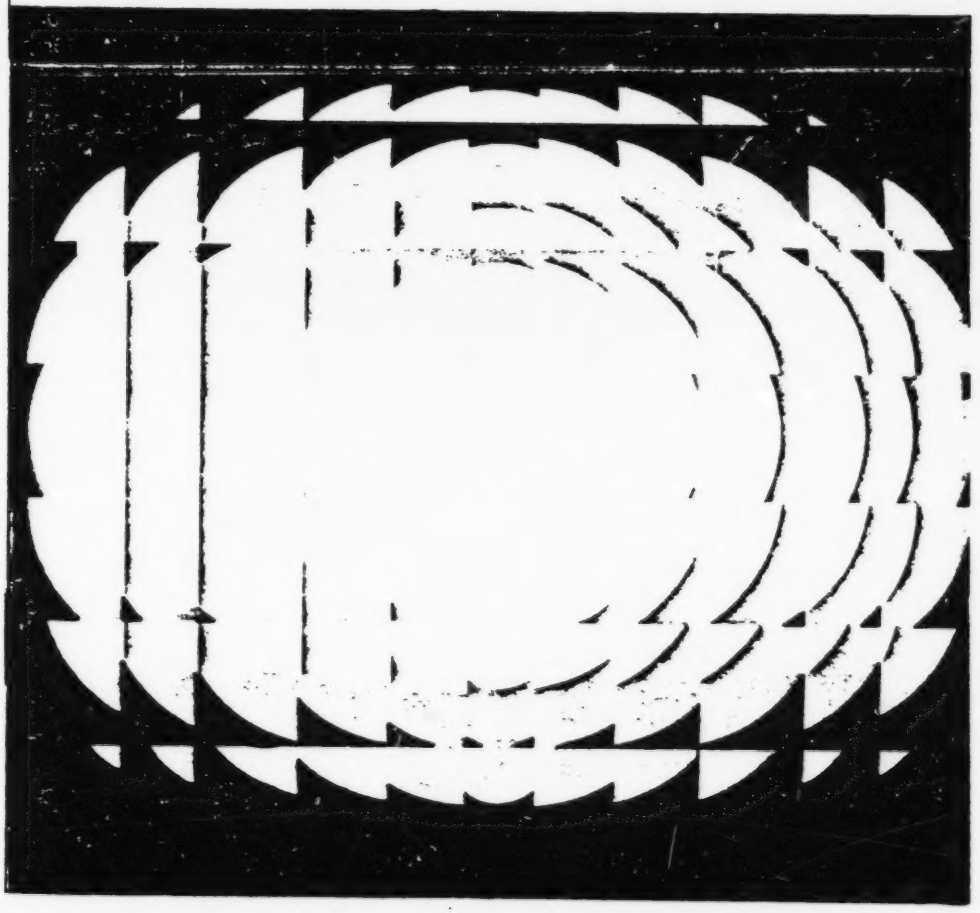


MODEL 124 PULSER
(120 Adapter and 24 Pulser)

COLOR DISPLAY

MODEL CM-1481

OPERATING GUIDE



HITACHI

SPECIFICATIONS

Input signal	
Video signal	NTSC standard composite color video signal video: positive, sync: negative input level: 1.0Vp–p / 75 Ω
Audio signal	0.5Vrms
Power input	AC120V ±10% 60Hz
Power consumption	73W (1.0A)
Convergence	Self convergence
Focus	Electrostatic
Picture tube	370 FVB 22 (13 inch, 90 degrees)
Sound out	2W
Speaker	12 x 8 cm, 8 Ω
Input terminal	Video in: RCA phono-jack Audio in: miniature earphone jack
Transistors	15
Diodes	27
IC	1
Modules	4
Weights	Appr. 11.6kg
Dimensions	(W) 43.3 x (H) 37.5 x (D) 38.6 cm

HITACHI

4540971

Printed in Japan YM-H (S)

Catalog Section A
Series A19
Bulletin No. 3531-H
Supersedes 3531-G

JOHNSON CONTROLS

Johnson Controls, Inc.
Control Products Division

2221 Camden Court
Oak Brook [illegible] 60521

Series A19 Temperature Controls For Refrigeration With NEMA 1 Enclosure

Application

These controls are designed to cover a broad range of general purpose operating temperature control applications in the refrigeration, air conditioning and heating field with a minimum number of models. Typical applications are: frozen food cases, display cases, beverage coolers, milk coolers, walk in boxes, water chillers, etc. Various control ranges are available to cover working temperatures from −30 to 225°F (−35 to 105°C). Closed tank fittings and bulb wells are available for immersion applications.

Single stage controls less enclosure and two-stage controls with or without enclosure also are available. Contact the nearest Johnson Controls office or write Customer Service.

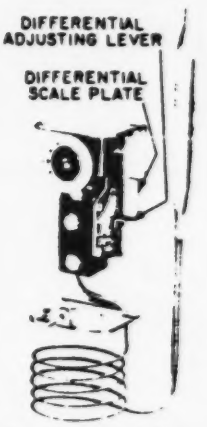


Fig. 1 — Interior of A19 with differential adjustment. Differential adjustment is concealed when cover is on control.

Specifications

Case Material		.062" (1.6mm) Cold Rolled Steel
Conduit Opening		⅞" Diameter Hole for ½" Conduit
Contact Unit		Snap-Acting Contacts in Dusttight Enclosure
Cover Material		.025" (0.6mm) Cold Rolled Steel
Finish		Gray Baked Enamel
Shipping Weight	**Individual Pack**	1 lb. (0.45 kg)
	Overpack of 50	55 lbs (25 kg)
Terminal Screws		No. 8-32 x ¼" Binder Head with Cup Washers

Range and Differential Specifications

Range °F / °C	Differential °F / °C — Adjustable	Differential °F / °C — Standard (Fixed)	Differential °F / °C — Close (Fixed)	Bulb Size in / mm	Max. Ambient °F / °C (1)
−30 to 50 / −35 to 10	5 to 20 / 2.8 to 11.1	5 / 2.8	2½ / 1.4	⅜ x 4 / 9.5 x 102	140 / 60
−30 to 100 / −35 to 40	3 to 12 / 1.7 to 6.7	3 / 1.7	1½ / 0.8	⅜ x 4 / 9.5 x 102	140 / 60
−20 to 60 / −6 to 15	5 to 20 / 2.8 to 11.2	5 / 2.8	2½ / 1.4	⅜ x 4 / 9.5 x 102	140 / 60
20 to 80 / −5 to 28	3½ to 14 / 1.9 to 7.8	3½ / 1.9	1¾ / 0.97	⅜ x 5 / 9.5 x 127	140 / 60
25 to 225 / −3 to 105	7 to 28 / 3.9 to 15.6	7 / 3.9	3½ / 1.9	⅜ x 3 / 9.5 x 76	275 / 135
30 to 50 / 0 to 10	4 to 16 / 2.2 to 8.9	4 / 2.2	2 / 1.1	⅜ x 2⅝ / 9.5 x 67	190 / 88
30 to 110 / 0 to 43	3½ to 14 / 1.9 to 7.8	3½ / 1.9	1¾ / 0.97	⅜ x 5 / 9.5 x 127	140 / 60
40 to 90 / 5 to 32	3½ to 14 / 1.9 to 7.8	3½ / 1.9	1¾ / 0.97	⅜ x 6 / 9.5 x 152	140 / 60
50 to 130 / 10 to 55	3½ to 14 / 1.9 to 7.8	3½ / 1.9	1¾ / 0.97	⅜ x 5 / 9.5 x 127	170 / 77

(1) Maximum bulb temperature which the element can withstand at infrequent intervals during life of control, such as shipping conditions.

This is not the temperature which the control can withstand on repeat cycles. Maximum ambient temperature around control case is 140°F (60°C).

These controls are designed for open high and open low applications. Where critical or high value products are to be maintained within a specific temperature differential, a single control should not be applied to function as both an open high and open low control. In these applications, a separate back-up control with alarm contacts should be wired to indicate when the back-up control operates.

Features

— Compact general purpose temperature controls with a wide selection of models.

— Dependability . . . precision snap-acting contacts in dusttight enclosure and liquid filled sensing element are field proven.

— Precision "repeat" accuracy which is unaffected by barometric pressure and cross ambient temperature problems.

— Concealed differential adjustment discourages unauthorized adjustment changes.

— Extremely close differentials . . . fixed or adjustable.

— "Trip-free" manual reset . . . reset must be *pressed and released* before operation will resume Contacts cannot be blocked in the closed position.

General Description

These compact controls are supplied with fixed or adjustable differential. Controls supplied with adjustable differential have an internal scale plate indicating the differential in degrees Fahrenheit.

Ranges of 20/80°F (−5/28°C), −30/+50°F (−35/10°C) or −30/+100°F (−35/40°C) have direct reading differential scale plate. Other ranges require a scale plate with multiplier. *Example:* X2 setting means when minimum differential is 5°F (2.8°C) then X2 differential is 10°F (5.6°C). Knob range adjustment and visible scale are standard. Models are available with a knob assembly for field convertible adjustment. These models are supplied with a snap-in plug in the cover for concealed screwdriver slot adjustment. An Allen wrench is included for knob assembly. A bulb mounting clip with sheet metal screw is supplied with remote bulb models. A special designed, field-proven liquid filled sensing element provides precision "repeat" accuracy which is unaffected by barometric pressure and cross ambient temperature problems.

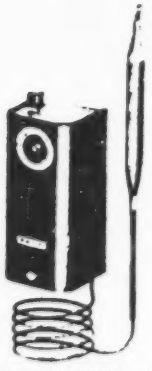


Fig. 2 — Type A19ACA with external range adjustment and manual reset.

Fig. 3 — Series A19 with external range adjustment.

Types A19ACA and A19ADB controls lockout requiring that reset be pressed and released before operation will resume. All other controls in this series are automatic recycling.

Optional Constructions

Ambient Compensation

Available on fixed differential and manual reset models at extra cost, if required. Write Customer Service.

Capillary Length

Standard is 6' (1.8m). Optional lengths are 10' (3m), 15' (4.6m) and 20' (6.1m). (Quantity orders.)

Mounting Brackets

Optional at extra cost.

Packing Nut

Part No FTG13A-600R is available for closed tank applications where the temperature does not fall below −35°F (−37°C) or exceed +250°F (121°C). Maximum liquid

Electrical Rating Tables

Standard Differential

Volts A.C.	120	208	240
Full Load Amps.	16.0	9.2	8.0
Locked Rotor Amps.	96.0	55.2	48.0
Non-Inductive or Resistance Load Amps. † (Not Lamp Loads)	22 Amps. 120 to 277 V. A.C.		
Pilot Duty — 125 VA.	24 to 600 V. A.C.		

† SPST RATING.

Standard Differential With Lockout

Volts A.C.	120	208	240
Full Load Amps.	16.0	9.2	8.0
Locked Rotor Amps.	96.0	55.2	48.0
Non-Inductive or Resistance Load Amps. (Not Lamp Loads)	16.0	9.2	8.0
Pilot Duty — 125 VA	24 to 600 V. A.C.		

Close Differential

Volts A.C.	120	208	240
Full Load Amps.	6.0	3.4	3.0
Locked Rotor Amps.	36.0	20.4	18.0
Non-Inductive or Resistance Load Amps. (Not Lamp Loads)	10 Amps. 24 to 277 V. A.C.		
Pilot Duty — 125 VA.	24 to 277 V. A.C.		

FORM C240

neptune 1/8", 3/8", and 3/4" VLF METERS (for low flow)

VLF4 (¼") VLF8 (⅜") VLF20 (¾")

The Neptune line of VLF Low Flow Meters is designed to measure light fuel oil or diesel oil. Offered in three sizes, 1/8", 3/8", and 3/4", flow can be measured at rates from 1 to 1500 dm³/h (.25 to 390 gph). Accuracy is ± 1%, repeatability, ± 1/4%.

The oscillating piston of these meters forms two measuring chambers that are alternately filled and emptied. The passing oil is measured by fractions and immediately displaced. Even smallest flow quantities are registered by the meter.

The register unit of the VLF8 works accurately in a vacuum sealed casing. It is absolutely secured against dirt, dust and condensation.

Operation of the VLF4 and VLF8 can be supervised any time by checking the disc rotation in the dial center. This allows accurate monitoring and prompt adjustment of the burner. While the oil burner is in operation, the flow quantity can be determined and compared with the optimal adjustment within a few minutes, allowing full control of oil consumption.

The VLF8 (3/8") and VLF20 (3/4") meters can be used to meter water or similar non-lubricants simply by changing the piston from anodized aluminum to hard rubber or graphite. This is particularly suitable for such applications as commercial laundries, drink dispensers, and mixing of heating oil emulsions in furnaces.

The VLF meter can be mounted in any flow direction, but the dial must either face upwards or not more than 90° to one side.

Machined to close tolerances (± 0006), these precision instruments are particularly sensitive to foreign matter. There is a fine filter built into the inlet but, should the liquid being metered contain foreign matter, it is recommended that a screen or removable filter of appropriate size be fitted on the inlet side. The filter mesh should not be larger than 50 micron for the VLF4 and VLF8 meters, or 100 micron for the VLF20.

SPECIFICATIONS

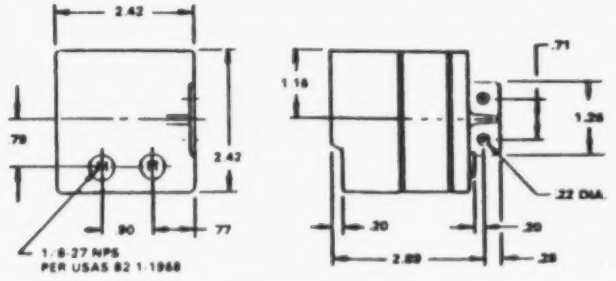
RATE OF FLOW
- 1/8"—1 to 30 dm³/h (.25 to 8 gph)
- 3/8"—4 to 150 dm³/h (1 to 40 gph)
- 3/4"—20 to 1500 dm³/h (6 to 390 gph)

OPERATING PRESSURE
- 1/8"—16 BAR max. (225 psi)
- 3/8"—16 BAR max. (225 psi)
- 3/4"—16 BAR max. (225 psi)

OPERATING TEMPERATURE
- 1/8"—50°C max. (125°F)
- 3/8"—60°C max. (140°F)
- 3/4"—130°C max. (260°F)

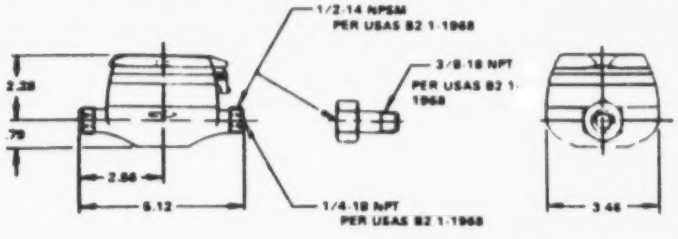
DIAL REGISTRATION
- 1/8"—increments to be .001 dm³ (.01 USG)
- 3/ "—increments to be .01 dm³ (.01 USG)
- 3/4"—increments to be .1 dm³ (.1 USG)

DIMENSIONS
See outline drawings.



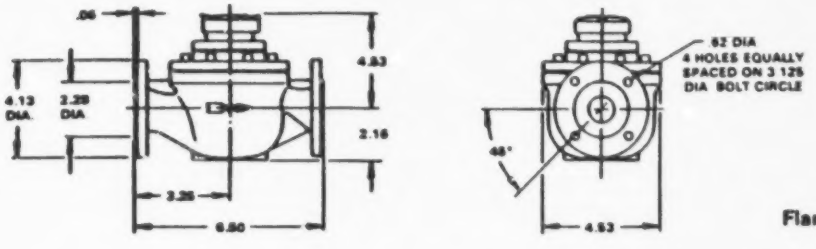
VLF4 (1/8")

(All dimensions are in inches.)



VLF8 (3/8")

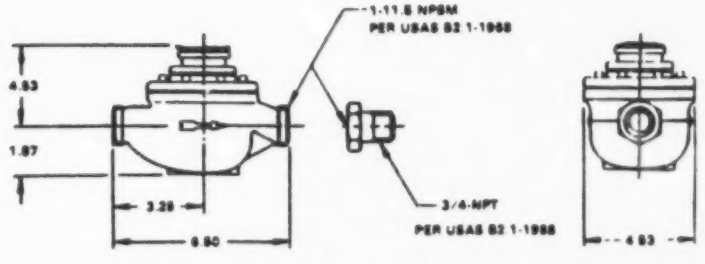
(All dimensions are in inches.)



VLF20 (3/4")

(All dimensions are in inches.)

Flange connections



Threaded connections